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GEOGRAPHICAL REVIEW

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OUR CONTRIBUTORS

MISS SEMPLE has written extensively on the influence of geographic environment on man. Her "Influences of Geographic Environment" (1911) is a standard exposition of the subject in English. Her "American History and Its Geographic Conditions" (1903) is also widely known. She has made a special study of the geography of the Mediterranean in classical times. Miss Semple has contributed several papers to the *Geographical Review* and its predecessor, the *Bulletin of the American Geographical Society*.

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DR. ZIERER is assistant professor of geography at the University of California at Los Angeles.

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MR. VAN CLEEF is professor of geography at the Ohio State University. He has specialized mainly in climatology and the application of geography to business. He has also taken a particular interest in Finland and the Finnish people. He revisited that country and other Baltic States last year for the purpose of geographical study. His several contributions to the Society's journal include "The Finn in America" (*Geogr. Rev.*, September, 1918).

MR. HECK is chief of the Division of Terrestrial Magnetism and Seismology, U. S. Coast and Geodetic Survey. He is the author of numerous Survey publications on wire drag work, submarine acoustics, and various phases of magnetism and seismology.

PROFESSOR BROWN is head of the department of geography of the Rhode Island College of Education at Providence. He has made waterways a special field of study (see his "Our Waterway Requirements," *Geogr. Rev.*, February, 1918), devoting particular attention to the Mississippi River, whose physical geography and whose function as a pathway of commerce he has discussed in numerous papers, mainly in the *Bulletin of the American Geographical Society*. He is the author of "The Geography of Worcester, Mass." and other studies in city geography and he has also made many contributions to educational geography.

DR. LONGWELL is assistant professor of geology in Yale University. He is especially interested in problems of structural geology, his field work therein being done largely in southern Nevada. To the *Geographical Review* he has contributed "Geological Significance of Isostasy and Gravity Measurements: A Review" (January, 1925).

DR. NUNN, of Berkeley, California, is a student of early cartography. He is the author of "The Geographical Conceptions of Columbus: A Critical Consideration of Four Problems," the Society's *Research Series No. 14*.

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The Vegetation and Soils of Africa. By H. L. SHANTZ and C. F. MARBUT. With a section on land classification by the joint authors and a note on a rainfall map of Africa by J. B. KINCER. With 1 text map, 49 photographs, and a separate case of two maps (in color) 1:10,000,000, each with inset, 1:25,000,000, showing vegetation (on inset: soils) and land classification (on inset: annual rainfall). x and 263 pp. *Research Series No. 13*, 1923. $5.00.

The Geographical Lore of the Time of the Crusades: A Study in the History of Medieval Science and Tradition in Western Europe. By JOHN KIRTLAND WRIGHT. With 10 maps, mainly facsimiles of medieval maps, and 2 diagrams. xxi and 563 pp. *Research Series No. 15*, 1924. $5.00.

Peopling the Argentine Pampa. By MARK JEFFERSON. With 55 photographs, 9 maps, and 4 diagrams. viii and 211 pp. *Research Series No. 16*, 1926. $4.00.

The Northern Ḥeğâz: A Topographical Itinerary. By ALOIS MUSIL. With 66 photographs, 12 drawings, 4 plans, and 4 maps in the text; in pocket, map of the Northern Ḥeğâz, 1:500,000, in brown and black, and index map, 1:2,000,000. xii and 374 pp. *Oriental Explorations and Studies No. 1*. 1926. $7.00.

Geography of the Central Andes: A Handbook to Accompany the La Paz Sheet of the Map of South America on the Millionth Scale. By ALAN G. OGILVIE. With an introduction by ISAIAH BOWMAN. With 2 maps in color and 41 diagrams and photographs. 240 pp. *Map of Hispanic America, Publication No. 1*, 1922. $3.00 (if purchased with the La Paz map, $2.00).

Map of Hispanic America, 1:1,000,000 [15.78 miles to 1 inch], Provisional Edition, North H-11, **Baja California Norte**; North G-12, **Baja California Sur**; North F-16, **Yucatán**; North F-18, **Santiago de Cuba**; North E-18, **Kingston-Port-au-Prince**; North E-19, **Santo Domingo-San Juan**; North E-20, **Lesser Antilles North**; North D-20, **Lesser Antilles South**; North C-17, **Panamá**; North A-17, **Río Mira-Islas Galápagos**; South C-19, **Acre**; South D-19, **Puno-Río Beni**; South E-19, **La Paz**; South E-20, **Sucre**; South F-19, **Iquique**; South F-20, **Río Pilcomayo**; South G-19, **Atacama**; South I-18, **Canquenes y Islas Esporádicas**; South L-18, **Península de Tai-Tao**; South M-18, **Isla Wellington-Lago Argentino**. $2.00 each sheet.

Map of Hispanic America, 1:6,000,000 [about 100 miles to 1 inch], compiled from nearly 250 sources and showing railways, drainage, international and administrative boundaries, and towns in graded sequence down to those with a population of 4000. Produced in black in three sheets—measurements of 2 (to border) are 34 x 28 inches, and of the third 32¼ x 30 inches. 1922. $5.00.

Mapa de la Republica de Panama, 1:500,000 [7.89 miles to 1 inch] compiled from over 100 original surveys, many of them unpublished. Printed in five colors. Follows in general the scheme of the International Map of the World on the Millionth Scale, but hypsometric tints have been omitted and the provinces shown in color instead. Accepted as official map by the government of Panama. 33 x 63 inches. 1926. $3.00.

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

FIG. 1—The Poseidon temple on Cape Sunium (Cape Colonna). (From J. B. Lechevalier: Recueil des cartes, plans, vues et médailles, pour servir au voyage de la Troade, Paris, 1802.)

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THE TEMPLED PROMONTORIES OF THE ANCIENT MEDITERRANEAN*

Ellen Churchill Semple

FIG. 2—Cape Taenarum.

THE traveler who crosses the Aegean Sea from Smyrna to Athens is greeted at the threshold of Greece with a vision of ancient Hellenic beauty. As he rounds the bold promontory of Sunium, which marks the tip of the Attic peninsula, he beholds far up above him the temple of Poseidon crowning the headland, outlined against a sky blue as the cloak of the Madonna. Below it the cliffs of white crystalline limestone drop sheer for two hundred feet down to a cobalt sea, whose waves are fretted into lace as they break upon the rocks. Above, the white marble temple gleams in the early morning sunshine, posed between blue and blue. It is an arresting vision. No signs of life are near, except where a half-deserted cove, exposed to the fury of the southwest winds, receives an occasional boat or fisherman's smack. Why was the temple placed there? A location so striking seemed to indicate a compelling reason. One surmised that it might be either the welcome home for the returning fleet or merchantman of ancient days or a pious expression of thanks for a safe voyage which stirred in the hearts of the Attic sailors. But this reason seemed inadequate. Therefore one was moved to question

* Read before the twenty-third annual meeting of the Association of American Geographers at Philadelphia, December 28–30, 1926.

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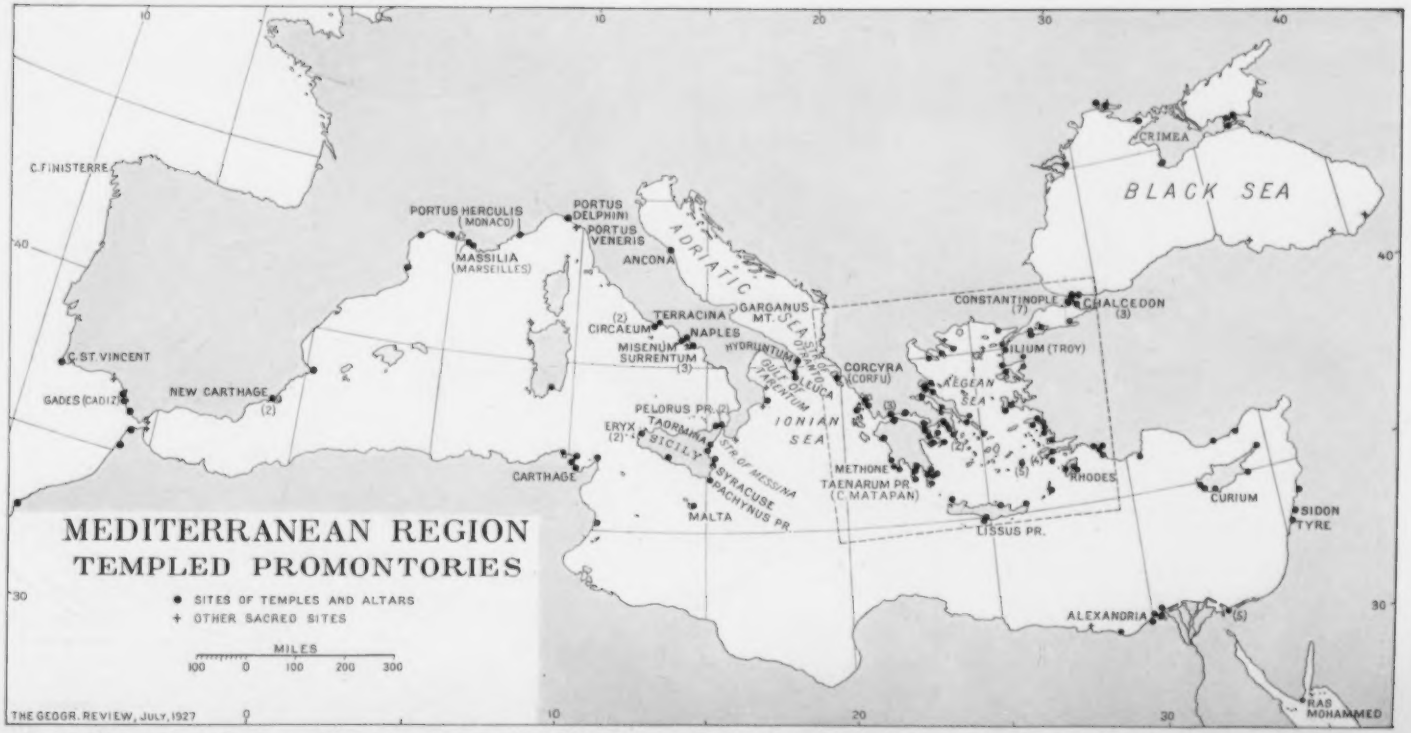

FIG. 3—Map of the Mediterranean region showing distribution of headland sanctuaries identified from classical literature. The dots show sites where altars or temples are known to have existed. Crosses show headlands regarded as sacred but lacking record of altar or temple. See Figure 4 for an enlarged map of the Aegean area. Scale of map, 1:25,000,000.

Use was made of the following authorities: Aeschylus, Anyte, Apollonius Rhodius, Appian, Archilochus, Aristophanes, Aristotle, Athenaeus, Catullus, Cicero, Diodorus Siculus, Euripides, Herodotus, Hesiod, Homer, Homeric Hymns, Horace, Josephus, Juvenal, Livy, Lucan, Macrobius, Ovid, Pausanias, Philostratus, Pliny the Elder, Plutarch, Polybius, Pomponius Mela, Procopius, Propertius, Ptolemy, Scylax, Seneca, Sophocles, Strabo, Suetonius, Tacitus, Thucydides, Vergil, Vitruvius, Xenophon.

whether there were other temples crowning other promontories on the busy sea lanes of the ancient Mediterranean. Moreover, out of the days of one's early Latinity, out of the murk of dative case and subjunctive mood, there loomed faint memories of temples along the southern promontories of Italy mentioned in the Aeneid, shrines to Athene and Hera and Castor and Pollux, those patron saints of ancient seamen.

The next move was to search the Mediterranean shores for these headland sanctuaries by throwing out a dragnet over all classical literature for the evidence, drawing in the facts from Homer and from Procopius, from Juvenal and from Livy. This research extended over fourteen years and is still incomplete. However, it assembled sufficient material to furnish a basis for some geographical conclusions. The investigation yielded one hundred and seventy-five of these promontory shrines, besides over a dozen consecrated headlands, known to the ancients as sacred but lacking any surviving record of altar or temple. Numerous other cases, not here included, rested upon suggestive but incomplete evidence.

Distribution of Promontory Temples

These sanctuaries were found to be distributed from the tip of the Sinai peninsula in the Red Sea,[1] a notorious spot for conflicting winds and currents dreaded by Greek and Roman seamen, all the way west to the angle of Portugal at Cape Finisterre, where a rude cairn of stones marked the consecrated worship of an ancient Melkart or Heracles.[2] They reached also from the Crimean Bosporus, where they clustered thick along the sea ways leading to the Scythian grainfields, south to Egypt and west to the headland of the Pyrenees,[3] where these mountains stretch out the rocky skeleton of an arm before they dive beneath the waves of the Mediterranean.

From the accumulated data it became possible to formulate certain generalizations as to the distribution of these headland sanctuaries, and even to conjecture their former sites while the facts were still unknown. Given certain winds and currents at certain promontories, a summit shrine or altar was almost inevitable, and nine times out of ten it was eventually located. For instance, the port of Ancona on the northeast coast of Italy, sheltered from the bora by a rocky cape of elbow form, is mentioned by Livy and Procopius as chief Adriatic naval base of the Romans. Search for nearer details about Ancona led through the poems of Catullus and the satires of Juvenal[4] and established the fact of a temple to the marine Aphrodite, built by the

[1] Strabo, *Geography*, XVI, 4 : 18.
[2] Strabo, *op. cit.*, III, 1 : 4.
[3] *Ibid.*, IV, 1 : 3.
[4] Catullus, 36, 13 : Juvenal, IV, 40.

Polybius, Pomponius Mela, Procopius, Propertius, Ptolemy, Scylax, Seneca, Sophocles, Strabo, Suetonius, Tacitus, Thucydides, Vergil, Vitruvius, Xenophon.

original Syracusan colonists to their tutelary deity. Local tradition in Ancona places the site of this temple on the tip of Monte Guasco promontory, whence the cathedral of Saint Ciriaco now overlooks the town (Fig. 5); but Peruzzi states that the ruins of the ancient temple, together with the extremity of Monte Guasco itself, fell into the Adriatic during an earthquake in 558 A. D.[5]

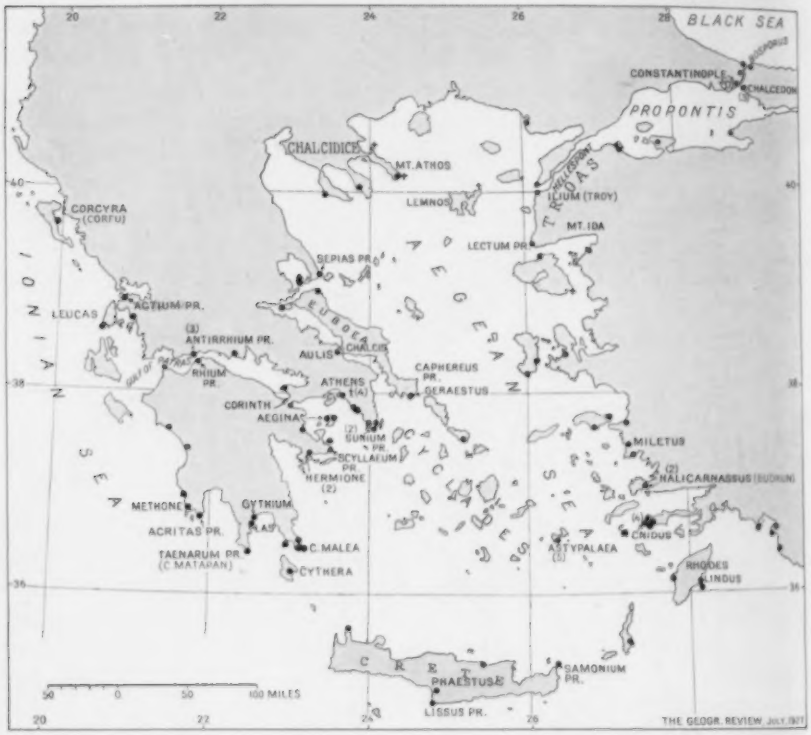

FIG. 4—Sacred headlands of the Aegean area. See the explanation accompanying Figure 3. Scale of map, 1:7,500,000.

FORMS OF HEADLAND SANCTUARIES AND THEIR ANTIQUITY

The form of these headland sanctuaries was varied. One type was the imposing Doric temple to Poseidon on the Sunium promontory (Figs. 1 and 7), or the rich fane of Venus of Eryx on the northwest angle which Sicily thrusts forward into the Tyrrhenian Sea.[6] A simpler form was the sacred grove with its shrine or marble canopy over the statue of the god, like the sacred precinct of Artemis on the northeast promontory of Euboea.[7] Most primitive was the wave-

[5] F. Hamilton Jackson: The Shores of the Adriatic: The Italian Side. London, 1906, p. 225.
[6] Polybius, *Histories*, I, 55; Diodorus Siculus, *Bibliotheca historica*, IV, 83.
[7] Herodotus, *Histories*, VII, 176; Plutarch, *Life of Themistocles*, VIII.

wrought cave which nature provided as a local shelter for altar or wooden image of the deity.[8] Pausanias mentions a cave with an image of Poseidon on Cape Taenarum. On the limestone walls of such grottoes grateful prayers have been found, inscribed by ancient seamen saved from shipwreck near the stormy headlands.

Most of these headland sanctuaries date back to the gray dawn of history. They were ascribed by the ancients to legendary builders of various races, like Orion, Daedalus, Heracles, Jason and the Argonauts, Cadmus, Danaus and his daughters, Neleus, Ulysses, Agamemnon, and Aeneas. The Tyrian Heracles, or Melkart, sea Baal of Phoenicia, had a large number to his credit. Many of the famous temples of historical times, like that of Sunium, Eryx, and the Lacinium cape (Capo Colonne) of southern Italy, were erected on the foundations of far earlier sanctuaries.[9] The original temple of Apollo Branchidae, or Didymus, crowning the Milesian promontory of the Ionian coast, antedated the Ionian immigration and the founding of Miletus.[10] The temple of Artemis on the Lindus promontory of Rhodes was also pre-Hellenic.[11]

FIG. 5—The harbor of Ancona showing the cathedral of San Ciriaco on Monte Guasco on the site of which local tradition places a temple of Venus. (From Pl. 78 of "Recueil de 155 des principaux plans des ports et rades de la Mediterranée" . . . . Genoa, 1801.)

In some cases a succession of deities were enthroned on these promontories. Maritime traders, colonists or oversea invaders brought their new gods and grafted them upon local divinities already established on the sacred headlands. The primitive sea goddesses Dictynna and Britomartis of Minoan Crete left their names and legends attached to certain rocky capes of the island,[12] but they themselves merged more or less into Artemis of the Doric invaders; later in the composite form of Dictynna Artemis they were transplanted in turn to various promontories of Greece and the Cyclades Islands.[13] In all cases the new incumbents succeeded to the site and its appropriate office, for all performed the divine function of protecting seamen.

[8] Pausanias, *Description of Greece*, III, 25 : 4.

[9] M. P. Nilsson: Griechische Feste von religiöser Bedeutung, Leipzig, 1906, p. 63; E. A. Freeman: The History of Sicily, from the Earliest Times (4 vols., Oxford, 1891), Vol. 1, pp. 199–209.

[10] Pausanias, *op. cit.*, VII, 2, 3.

[11] Diodorus Siculus, *op. cit.*, V, 58; Herodotus, *op. cit.*, II, 182.

[12] Herodotus, *op. cit.*, III, 59; Strabo, *op. cit.*, X, 4 : 12–14.

[13] Pauly-Wissowa: Real-Encyclopädie der classischen Altertumswissenschaft, article "Diktynna."

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FIG. 6—The Leucadian Promontory, the southern tip of Leucas, site of a temple of Apollo. In the left background, Ithaca, to the right Cephallonia. (From William Gell: The Geography and Antiquities of Ithaca, London, 1807.)

The Leucadian Promontory, the southern tip of Leucas, site of a temple of Apollo. In the left background, Ithaca, to the right Cephallonia. (From William Gell: The Geography and Antiquities of Ithaca. London, 1807.)

FIG. 7—Cape Sunium and its temple. (From O. M. Baron de Stackelberg: La Grèce, Vues pittoresques et topographiques, Paris, 1834, Vol. 2.)

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Winds and Currents

The importance of these promontories to ancient seamen is apparent in all classical literature. For the coastwise navigation of ancient and medieval times, when no compass directed the timid sailor, these headlands were sea marks for the groping prows of Greece and the adventurous sails of Tyre, for the beaked boat of the pirate as it nosed its way along the trail of the prey. The high relief of the Mediterranean coasts made the headlands conspicuous during the four summer months that formed the season of navigation, for then no fog or mist blurred their outlines. But their high relief also converted the straits and bays enclosed by them into sea canyons, through which the winds swept with restless violence in July and August when the northern air currents, the etesians of the Greeks whose marked regularity was noted by Hesiod,[14] reached their maximum strength. In June and September, when the prevailing winds shifted from north to south or from south to north, these headlands were points of conflicting gales and raging surf. They were known to the ancient seamen as places of severe storms, especially the wind storms of the Mediterranean summer. The poet Archilochus, who wrote in 700 B. C., gives us the picture:

> Behold, my Glaucus, how the deep
> Heaves, while sweeping billows howl,
> And round the promontory steep
> The big black clouds portentous scowl.

Many of these promontories were notorious, like Cape Malea, whence Jason, Ulysses, Menelaus, and countless other mariners were swept by the violent north wind south past Cythera and Crete to the African coast, hundreds of miles from their projected course.[15] The reputation of Malea was embodied in an ancient adage of Greek sailors, "If you pass beyond Malea, forget your home." Equally notorious was Mt. Athos, which capped the long eastern prong of the Chalcidice peninsula with a marble mass 6350 feet high. It was a seamark for all navigators in the northern Aegean, visible for long distances. At the summer solstice at sunset it cast a shadow fifty miles across the Aegean to the island of Lemnos and made early twilight in the market place of Myrina.[16] Thus it was a guide to seamen but also a terror. On its rocky base the Persian fleet in 490 B. C. was dashed to pieces by the northeast wind;[17] therefore Xerxes ten years later cut a canal across the base of the peninsula, that his fleet might pass in safety.[18] The headlands of Sicily and Italy which abut upon the Strait of

[14] For a meteorological description see J. S. Paraskévopoulos: The Etesiens, *Monthly Weather Rev.*, Vol. 50, 1922, pp. 417–422.

[15] Homer, *Odyssey*, III, 287; IV, 514; IX, 79–83; Herodotus, *op. cit.*, IV, 179.

[16] Apollonius of Rhodes, *Argonautica*, I, 601–606.

[17] Herodotus, *op. cit.*, VI, 44, 95.

[18] *Ibid.*, VII, 22, 23.

Messina converted the local tidal currents into a whirlpool, whose perils were embodied by the ancients in the monster myths of Scylla and Charybdis. Its evil reputation was not confined to legendary times when Ulysses and Aeneas shuddered at its terrors; for its tidal eddies embarrassed the Roman and Carthaginian fleets during the second Punic War.

FIG. 8—A seventeenth-century conception of the Strait of Messina. The strait is pictured from the northern entrance: on the left the Calabrian coast with Reggio; on the right Etna with the town of Messina at its foot. (From "Theatrum celebriorum urbium Italiae, aliarumque in insulis Maris Mediterranei," Joannes Jansonnius, Amsterdam, 1652?).

These promontories often caused vexatious delays. Ancient sailing vessels, like modern steamers, had to wait for days till the contrary winds subsided enough for the vessels to round the headlands. The Lectum promontory, forming the southwest end of the Troad peninsula, was a critical point on the sailing route along the eastern shore of the Aegean; for the etesian winds of midsummer swept down from the Black Sea and swirled around this headland with a force which daunted the bravest seaman. Here in the summer of 479 B. C. the Hellenic fleet, bound for the Hellespont from the victory over the Persians at Mycale on the Asia Minor coast, had to moor their ships on the leeward side of Lectum for several days, "being stopped from their voyage by the winds," Herodotus tells us.[19] This was a common experience, evidenced by an altar to the Twelve Great Gods which crowned the summit of Lectum and was said to have been dedicated by Agamemnon himself.[20] The fleet of Corcyra, summoned

[19] *Ibid.*, IX, 114.
[20] Strabo, *op. cit.*, XIII, 1 : 48.

FIG. 9—The entrance to the Black Sea from the Bosporus. (From Julia Pardoe: The Beauties of the Bosphorus, London, 1830. Original drawing by William H. Bartlett.)

to aid the Greek forces at the battle of Salamis, arrived after the fighting was over, claiming that they had been unable to round Cape Malea against the etesian winds, a plausible excuse.[21]

FAMILIAR LANDMARKS

But these promontories were also the first points of the homeland to greet the returning seaman after his eventful voyage, or they marked his arrival in familiar waters. Hence at one of the harbors which usually flanked the ends of the headlands, he beached his ship if the sea was calm and climbed to the summit sanctuary to offer his thanks for a safe journey. Classical literature gives us many instances of this. Jason and the Argonauts, returning from the shadowy land of Colchis and the rocky coast of the Caucasus, rejoiced on reaching the headland that marked the northern entrance of the familiar Bosporus and there built an altar to the Twelve Great Gods.[22] Ever afterwards this spot was sacred and became the site of a temple to Zeus. The Greeks returning from the siege of Troy under Nestor landed at the promontory of Geraestus, which formed the lofty southern tip of Euboea, and there at the temple of Poseidon they sacrificed cattle as a thank offering for their safe return.[23] Another group of these victorious warriors had been shipwrecked on the notorious Cape Caphereus

[21] Herodotus, *op. cit.*, VII, 168.
[22] Pomponius Mela, *De situ orbis*, I, 19 : 37; Polybius, *op. cit.*, IV, 39.
[23] Homer, *op. cit.*, III, 176.

FIG. 10—The bold headlands of the Sorrento Peninsula. (From "Atlante geografico e illustrativo della corografia dell' Italia," [Florence, 1845?], Vol. 4.)

twenty miles to the north, and their fate served to emphasize the good fortune of Nestor and his companions.[24]

Hence these rock-bound capes became the sites of temples, mute prayers in stone for divine protection from the perils of the deep, till the Greek mind came to regard the wooded *temenos*, or sacred precinct, as the normal appurtenance of a promontory. Ajax, dying in the distant Troad, thus describes his native island of Aegina:

> Paths of the dashing surge,
> Caves by the ocean's edge,
> Grove on the promontory brow.[25]

MEMORIALS AND TOMBS ON PROMONTORIES

The tendency to regard promontories as rocky thrones, whence the gods watched over the maritime ventures of men, probably explains the ancient custom of commemorating naval victories by erecting trophies on neighboring headlands, usually in a temple precinct. The Greeks set up a circle of white stone pillars around the temple on the Artemisium promontory of northeast Euboea as a thank offering for the destruction of the Persian fleet in the strait below (480 B. C.). The Athenians, after their victory over the Spartans at the battle of Naupactus (429 B. C.), erected a tropy and dedicated a captured ship in the temple of Poseidon on the Rhium promontory, whence the

[24] Ovid, *Metamorphoses*, IV, 472; XIV, 481.
[25] Sophocles, *Ajax*, 412.

friendly god had looked down on the engagement in the Corinthian Strait. Augustus Caesar registered his gratitude for the naval victory of Actium by enlarging and beautifying the very ancient temple of Apollo which crowned this headland. Occasionally a promontory received its first dedication by such trophies; as when Corcyra won its great victory over the Corinthian fleet in 435 B. C. and, to commemorate the event, raised a monument on Cape Leucimne, a southern head-

FIG. 11—The harbor of St. Nicholas, Cythera. The temple of Aphrodite lay a few miles inland. (From Stackelberg, La Grèce, Vol. 1.)

land of the island hitherto unmarked by any sanctuary, though one is prone to surmise there some native Corcyrean shrine whose god protected his own.

The sanctity attached to headlands probably explains the ancient custom of placing on them the tombs of heroes, consecrated with altars and monuments. In time the tombs developed into temples and the heroes into gods. The rocky capes that flanked the southern portal of the Hellespont were crowned with sepulchers, raised to the heroic dead of the Trojan War. The high tip of the Chersonesus held the Protesilaeum, tomb and temple of Protesilaus, the first Greek chief killed in the Trojan campaign.[26] The fane grew in sanctity and wealth for centuries; in 480 B. C. it was pillaged and defiled by the Persian viceroy, who, according to Herodotus,[27] paid dearly for the desecration. On a minor headland near by was the sepulcher of Hecuba, queenly victim of the war;[28] and four miles across the swift-flowing Hellespont was the Sigeum promontory, the Westminster Abbey of the early Hellenic race. There under blue Aegean skies rose the temple and tomb of Achilles, which held also the ashes of Patroclus[29] and on which the great Alexander placed a wreath of tribute; there also was the tomb of Antilochus. Three miles beyond, overlooking the mouth of the Scamander, was the Rhoeteum promontory with its sepulchral temple of Ajax.

[26] Thucydides, *History of the Peloponnesian War*, VIII, 102; Strabo, *op. cit.*, XIII, 1 : 31.
[27] Herodotus, *op. cit.*, IX, 116–120.
[28] Strabo, *op. cit.*, XIII, 1 : 28.
[29] Homer, *op. cit.*, XXIV, 75.

This method of consecrating promontories was not confined to the heroic age. The tomb of Themistocles has recently been identified on the blunt headland overlooking the outer harbor of the Piraeus from the north; and, with rare appropriateness, straight across the harbor channel on the Acte promontory rises the sepulchral monument of the Greek Miaulis, naval hero of the War of Liberation (died 1855). On the west coast of Italy, Cape Palinuri, Cape Miseno, and the promon-

FIG. 12—Modon, the ancient Mothone, a sheltered harbor west of Cape Acritas. (From Stackelberg, La Grèce, Vol. I.)

tory of Gaeta all owe their names to the tombs of heroic seamen who explored this coast with Aeneas.

Achilles, the son of Thetis, developed into a genuine promontory god. The Euxine and the Propontis became his special domain, and there he was worshipped as the "lord of the Pontus."[30] His altars tipped many a sand and boulder spit along those coasts, and he had a famous sanctuary on Leuce, "the shining island" near the mouth of the Danube whose warders were sea birds;[31] but he also received divine honors on the Aegean island of Astypalea.[32]

THE PROMONTORY GODS

There was a large variety of these promontory gods. Some were primarily marine deities, like Poseidon, Castor and Pollux, the deified Achilles[33] and his goddess mother Thetis who presided over the rocky headland of Sepias. Here the northeast wind from the Black Sea dashed to pieces the Persian fleet of Xerxes as it was preparing to enter the rocky channel of the Euboean sound.[34] The universal maritime activity of the Mediterranean coast peoples, however, diverted other gods from their original tasks to assist the struggling sailor. Zeus became Zeus Soter, savior of seamen, and was assisted in this task by

[30] J. B. Bury: A History of Greece to the Death of Alexander the Great, 2nd edit., London, 1913, p. 92.

[31] Strabo, *op. cit.*, VII, 3 : 16.

[32] Cicero, *De natura deorum*, III, 45.

[33] Bury, *op. cit.*, p. 92.

[34] Herodotus, *op. cit.*, VII, 191.

Hera, or Juno. Apollo, Athene, and Hermes, god of travelers, were also enlisted in a like service.

Yet remoter deities from inland countries were set to work at the alien duty of helping the ancient navigators. Interesting in this connection is the evolution of Astarte, crescent-crowned moon goddess of Assyria, giver of fertility. She became known to the Phoenicians, who traded along the piedmont route of northern Mesopotamia, as a deity of great power; so they adopted her and took her to their crowded ports on the coast of the Lebanon Mountains. Having little use for her fertilizing powers, they made her patron goddess of their busy merchantmen. The Tyrians placed her figure at the prow of their boats, where she breasted the Mediterranean waves; and they took her on all their wide voyages, to set her up on capes and headlands beside their distant factories and colonies. Tyrian traders introduced her among the Hellenic colonies of Asia Minor, where Astarte became identified with Artemis and achieved fame as the Diana of Ephesus. This hybrid goddess of the crescent was adopted by many Aegean Greek cities as the patron of seamen. She became identified with sea-born Aphrodite, goddess of love and fertility, and as such her worship spread from the Tyrian colony on the little island of Cythera among the peninsular Greeks; but she still retained her Phoenician rôle of patron goddess of seaman.[35] Among the Romans she merged into Venus. Under these various names, but maintaining an identical character, she can be traced all the way from Sidon and Ascalon[36] to Massilia and the Spanish coast, along the sea tracks of Phoenician and Greek settlers.

The Tyrians gave a like distribution to the sanctuaries of their local sea Baal Melkart, who became identified with the Greek Heracles and in this character had his temples and altars on widely scattered headlands from Tyre to the sacred promontory of Iberia. Under his Roman name he presided over the Pillars of Hercules, where he looked down upon the full current and strong winds of the famous strait. Malign deities represented the terrors of dangerous headlands and were embodied in the Scylla monster who destroyed ships in the whirlpool of the Strait of Messina;[37] she also occupied the Scyllaeum promontory of southeastern Argolis,[38] where the etesian winds at midsummer swept around the end of this peninsula. Similar was the Italian Circe who lured seamen to their destruction on the surf-beaten rocks of the Circaeum promontory.[39] Similar too were the Sirens, localized by legend on the rocky islets off the Sorrento peninsula.

[35] Pauly-Wissowa, article "Astarte."

[36] Herodotus, *op. cit.*, I, 105.

[37] H. F. Tozer: Lectures on the Geography of Greece, London, 1873, p. 77.

[38] Pausanias, *op. cit.*, II, 34 : 7–8.

[39] Cicero, *op. cit.*, III, 48: Vergil, *Aeneid*, VII, 10–24; Apollonius of Rhodes, *op. cit.*, III, 312; Strabo, *op. cit.*, V, 3 : 6.

FIG. 13—The central peninsula of the Peloponnesus with its termination in Cape Taenarum (C. Matapan). (This view and Figure 2 from Stackelberg, La Grèce, Vol. 1.)

All of these deities, both beneficent and malignant, had their seats upon the headlands of the Mediterranean shores. A fragment of Sophocles thus apostrophizes the god of the sea:

> Thou Poseidon, who art lord over the cliffs and glassy
> waves of the wind-swept Aegean, behold thy dwelling place
> on the lofty crags of all the harbors.

Poseidon was "enthroned on Geraestus and Sunium bold," according to Aristophanes.[40] He had his famous sanctuary on the long promontory of Cape Matapan, the ancient Taenarum (Fig. 13), where a grove and cave sheltered the image of the god.[41] The little harbor to the northeast of the sacred precinct was a refuge for storm-driven seamen; it was also the starting point for the voyage south to Crete and Africa and thence to Egypt.[42] The Venetians later called it the Bay of the Quails, because these birds of passage assembled there for their flight to the winter grainfields of Egypt.

In like manner Apollo was ensconced upon the windy promontories. "Many are thy fanes and groves, and dear to thee are all the headlands," sings the Homeric hymn to Apollo.[43] He frequently shared these sites with Artemis, who "was goddess of the stormy headlands." Aphrodite was called "the giver of fair voyages," "she who keeps a lookout from the headlands," "Aphrodite of the Heights." On a little promontory which sheltered the port of the city of Aegina from the north winds was a temple dedicated to "Aphrodite of the Harbor" (Figs. 15 and 16), now marked by a single surviving column.[44] Her

[40] Aristophanes, *The Knights*, 559–560.
[41] Strabo, *op. cit.*, VIII, 5 : 1; X, 1 : 7; Pausanius, *op. cit.*, III, 25 : 4.
[42] Conrad Bursian: Geographie von Griechenland (2 vols., Leipzig, 1862, 1872), Vol. 2, p. 150.
[43] Homeric Hymn to Apollo, 143–144.
[44] Pausanias, *op. cit.*, II, 29 : 6.

FIG. 14—The temple of Athene in Aegina. In the background the coast of Attica. (From Stackelberg, La Grèce, Vol. 1.)

character is described by Anyte of Arcadia, who wrote in 700 B. C. a poem to Aphrodite of the Sea:

> Cythera from the craggy steep
> Looks downward on the glassy deep,
> And hither calls the breathing gale
> Propitious to the venturous sail,
> While Ocean flows beneath serene,
> Awed by the smile of Beauty's Queen.

The ancient Greek city of Cnidus, which occupied the rocky tip of the Triopium promontory on the southwest coast of Asia Minor, dedicated its oldest sanctuary to the Bountiful Aphrodite, a later one to Aphrodite of the Height, and a third to the Aphrodite of the Fair Voyage.[45] This Cnidian Aphrodite was clearly a Greek form of the Phoenician Astarte, who appears on the island of Samos as Hera,[46] and as Artemis in Hellenic Euboea and on the native shores of the ancient Argonauts. Orpheus, bard of these daring explorers, according to Apollonius Rhodius "sang of the Savior of Ships, Artemis, her that holds the headlands of these seas in her keeping."[47]

Athene also was drawn into the service of the Mediterranean seamen. She had her temple on "sacred Sunium,"[48] near the famous shrine of Poseidon, and shared with him the task of assisting seamen to round this windy promontory. As "Guardian of the Anchorage" she had her sacred seat on a rocky cape sheltering the port of Hermione on the southern coast of Argolis, while a temple of Poseidon kept its

[45] *Ibid.*, I, 1 : 3.
[46] *Ibid.*, VII, 4 : 4–5; Encyclopaedia Britannica, article "Hera."
[47] Apollonius of Rhodes, *op. cit.*, I, 568.
[48] Homer, *op. cit.*, III, 278.

FIG. 15—Ruins of the Temple of Aphrodite at Aegina as seen in the late eighteenth century. Compare Figure 16. (From "The Antiquities of Ionia," Part II, Society of Dilettanti, London, 1797.)

lookout on a neighboring headland.[49] Athene was "mistress of the winds" in her sanctuary on the southwest promontory of Messenia, where she protected the sailors seeking their home port of Mothone (Fig. 12);[50] for this point was exposed to the storms that swoop down from the Adriatic and to the violent south winds of spring that bring rain from the coast of Africa.

CHRISTIAN SAINTS REPLACE THE PROMONTORY GODS

These gods have passed, but their function still remains; their headlands are not deserted. In the Aegean Sea nearly all these high temple sites are occupied today by little chapels of St. Nicholas, the patron saint of sailors brought up in the Greek Catholic Church. St. Nicholas is dear to the heart of the modern Aegean seamen. His icon is fastened to the mast of every fishing boat, and below it hangs an ever-burning lamp. Prayers ascend to him in every storm, and sacrifices of salt and bread are cast into the sea by the pious sailors when they round his promontories.[51] Many of these little churches are located on the very site of the ancient pagan sanctuaries, and one may see sculptured stones from an Aphrodite or Poseidon temple built into the chapel walls. In the western Mediterranean, in the realm of the Roman Catholic Church, the Virgin Mary is the Stella Maris, Star of the Sea, to the modern sailor; humble successor of Artemis and Venus, she has her chapel or church on the site of ancient temples and is besought in prayer by the modern Sicilian or Italian sailor for a safe voyage.

[49] Pausanias, *op. cit.*, II, 34 : 8–10.
[50] *Ibid.*, IV, 35 : 1, 5, 6.
[51] Mary Hamilton: Greek Saints and Their Festivals, Edinburgh and London, 1910, pp. 28–31.

Harbor Promontories and Their Sanctuaries

These promontory sanctuaries reveal two geographic principles in their distribution. They appear singly or in groups about the harbor entrances of active seaboard towns, where headlands run out like piers and protect the port from prevailing winds. The ancient sailing vessels evidently experienced difficulty in getting into harbor, though they used the diurnal winds for this purpose, as the Mediterranean

Fig. 16—The port of Aegina and the ruins of the temple of Aphrodite. In the middle distance is a chapel of St. Nicholas. (From Stackelberg, La Grèce, Vol. 1.) Stackelberg (1834) says: "It is reported that the better preserved of the two columns has fallen down and the débris used in the building of new houses."

sailor does today. But these sea breezes were comparatively weak and often were overpowered by the stronger currents of air. Moreover, along the steep coasts of the Mediterranean falling winds or squalls from the highland interiors added to the complexity of the wind systems and increased the difficulty of reaching port, especially on southward-facing slopes.[52] They explain the successive headland temples along the whole south coast of Asia Minor and of the Troad along the base of Trojan Ida, of mountainous Crete and Rhodes, southern Italy, and the seaboard of the Alps and northern Apennines. Along the Italian Riviera, the Portus Herculis of ancient Monaco,[53] Portus Delphini[54] near modern Rapallo (Fig. 20), and Portus Veneris near Spezia had their names from promontory shrines.

These port sanctuaries were numerous. The ancient Hellenic colony of Massilia (Marseilles), by reason of its location near the mouth of the Rhone, lay in the path of the mistral, the desolating wind that pours down the Rhone valley from northern France and the Cévennes. The ancients knew it in winter to overturn loaded wagons crossing the Rhone delta and in the summer sailing season to buffet vessels entering or leaving the port of Massilia. The harbor was a natural basin between two limestone ridges of the Provence hills, which afforded

[52] C. Naumann and J. Partsch: Physikalische Geographie von Griechenland, Breslau, 1885, pp. 104–107; Alfred Philippson: Das Mittelmeergebiet, Leipzig, 4th edit., 1922, pp. 96–97.

[53] Lucan, *Pharsalia*, I, 405; Strabo, *op. cit.*, IV, 6 : 3.

[54] Pliny, *Hist. nat.*, III, 7.

protection against the mistral and determined the selection of the site by the ancient Phocaean colonists. These Asia Minor Greeks, coming from a region long impressed with Phoenician cults, brought with them the worship of Artemis of Ephesus and erected a temple to her on the northern headland protecting the port, where today rises the old cathedral of Marseilles. On other bold points abutting on their harbor they built sanctuaries to Apollo and Poseidon and thus

FIG. 17—Ruins of a temple discovered in 1926 at Zoster. The Zoster Promontory on the west coast of Attica, a bold rocky headland, had altars to Apollo Zosterios, Artemis, Leta, and Athene Zosteria.

fortified themselves against the stormy mistral. Nor was this all. They planted their colonies and temples along the whole Mediterranean shore of Gaul and of the neighboring Iberia.[55] The remoter Massiliot colonies on the Spanish coast often found it impossible for weeks at a time to send their ships northward to the mother city against the mistral. They found it especially perilous to round the bold Pyrenean promontory, which was therefore crowned with a temple to Aphrodite.[56]

The southwest coast of Asia Minor suffered from the falling winds from the highlands of Lycia and the plateau interior; so the Greek cities along this coast studded the promontory approaches to their harbors with sanctuaries of the helpful gods. The city of Cnidus was located on the tip of the Triopium peninsula and a near-by islet, which was linked with the mainland by a causeway and thus formed an anvil-shaped headland sheltering two harbors (Figs. 21 and 22). On the lofty island extremity Cnidus placed a famous temple of Apollo, sacred to seamen along all that coast,[57] and one to Poseidon, while in her three sanctuaries in the city Aphrodite was cherished above all its other gods.[58] Cnidus, by reason of its restricted territory, its barren rocky soil, its meager home resources, and its crossroad location on the great north-south and east-west trade routes of the eastern Mediter-

[55] Strabo, *op. cit.*, IV, 1 : 3–4.
[56] *Ibid.*, IV, 1 : 6.
[57] Thucydides, *op. cit.*, VIII, 35.
[58] Pausanias, *op. cit.*, I, 1 : 3.

ranean, was early drawn into commercial and fishing ventures on the sea. Therefore its chief need was reflected in its worship of these sea deities. The near-by city of Halicarnassus, with a similar location and a similar career, had a harbor well protected both by nature and the gods (Figs. 23 and 24). A northern headland, in the form of a precipitous rock, contained its citadel and a temple of Aphrodite, while another sanctuary crowned the corresponding promontory on the

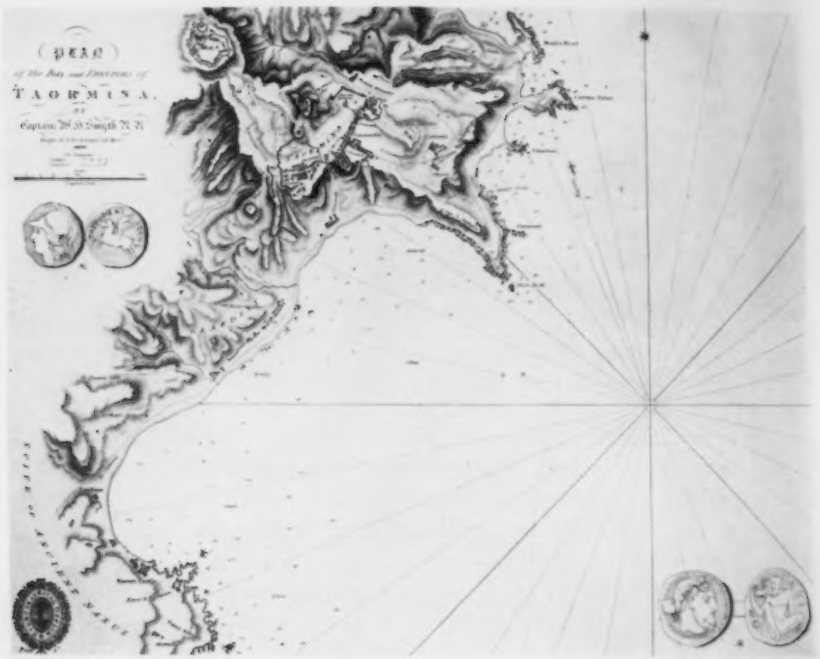

FIG. 18—Plan of the Bay of Taormina. Temples on the flanking promontories. Compare Figure 19. (From "The Hydrography of Sicily, Malta, and the Adjacent Islands; Surveyed in 1814, 1815, and 1816 . . . by Capt. William Henry Smyth," London, 1823.)

south.[59] The neighboring city of Miletus, famous in ancient commerce and colonization, was located on a club-shaped peninsula fronting the mouth of the Meander River (Figs. 25 and 26). The southern tip of this peninsula held an altar to Poseidon, said to have been founded in gray antiquity by Neleus, who established the Ionian colony of Miletus; while two miles inland on the promontory summit was the famous temple of Apollo of Didymus.[60] This was a rich sanctuary visible from afar, sought as a place of prophecy by all the dwellers of the Ionian coast. The temple itself was of Ionian origin, but it occupied the site of a far earlier sanctuary, which had probably been established by the early Carians of this coast.[61]

[59] Vitruvius, *De architectura*, II, 8; Diodorus Siculus, *op. cit.*, XVII, 23 : 4.
[60] Strabo, *op. cit.*, XIV, 1 : 5; Herodotus, *op. cit.*, V, 36; VI, 19; Pausanias, *op. cit.*, II, 10 : 3.
[61] Pausanias, *op. cit.*, VII, 2 : 3.

FIG. 19

FIG. 20

FIG. 19—Looking from the ruins of the theater of Taormina to Capo Schiso and Mt. Etna. Compare Figure 18. Capo Schiso was the site of the temple of Apollo Archegetes mentioned by Thucydides and Appian, and possibly of the temple of Venus visited by Octavian. Site of Greek colony of Naxos.

FIG. 20—The refuge harbor of Portofino, the Portus Delphini of Pliny, or Port of Apollo the Dolphin God. On the extremity of the promontory, beyond the two castles in the picture, is the church of the Madonna del Capo.

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On the peninsula of Greece the same story meets us. On Acte promontory, which sheltered the ports of Athens, a temple of Artemis protected the home-coming sailor.[62] Corinth, located on the Isthmus of Corinth, had no available promontory, but she constructed a long mole to shelter Cenchreae, her Aegean port, and on the tip she placed a bronze statue of Poseidon.[63] The high promontory (3467 feet) on the western side of the Isthmus (Fig. 29), which guarded the approach to her harbor on the Corinthian Gulf, was crowned with a temple of

FIG. 21—Plan of Cnidus, built on the Triopium promontory and the adjacent island. Compare Figure 22. (From "Antiquities of Ionia," Part III, Society of Dilettanti, London, 1840.)

Hera Acraea.[64] The tip of this headland is now called Cape St. Nicholas, and its summit bears a humble chapel to that helpful saint.[65] Even the land-loving Spartans had their two ports of Gythium and Las, on the mountainous coast of the Laconic Gulf, protected by a promontory temple, one to Aphrodite and the other to Artemis Dictynna.[66] In like manner these headland sanctuaries clustered thick about the ancient ports of Alexandria, Byzantium, Syracuse, Naples, Carthage, New Carthage, and Gades.

ALONG THE TRACK OF THE GRAIN SHIPS

The second principle of distribution is revealed along the main trade routes of the Mediterranean Sea. The temples are found on all these "wet ways" along the coast where conflicting winds and currents meet and where the surf beats high. The long path of the Hellespontine wind, which blew from the Scythian coast of the Black Sea

[62] Xenophon, *Hellenica*, II, 4 : 11.
[63] Pausanias, *op. cit.*, II, 2 : 3.
[64] Livy, *History*, XXXII, 23; Xenophon, *op. cit.*, IV, 5.
[65] Alfred Philippson: Der Peloponnes, Berlin, 1891, pp. 19–28.
[66] Pausanias, *op. cit.*, III, 22 : 1; Bursian, *op. cit.*, Vol. 2, p. 147.

down through the Bosporus and Hellespont and swept southwestward across the Aegean, marked the great northern grain route of the ancient Mediterranean; hence it was punctuated by templed promontories. The high water level in the Black Sea in early summer, due to the great volume of the northern rivers, caused a strong current out through the Crimean Bosporus and again through the Thracian Bosporus and Hellespont into the Aegean. Ships northward bound to

FIG. 22—View of the site of the ancient city of Cnidus taken from a point in the peninsula westward of the entrance into the smaller harbor. Compare Figure 21. (From "Antiquities of Ionia," Part III, Society of Dilettanti, London, 1840.)

the Scythian grainfields had to sail up against the Hellespontine wind and also breast this current, which through the tortuous channels of the Straits rebounded from shore to shore and greatly complicated the problem of navigation. Hence the jutting banks of the Crimean Bosporus had their sanctuaries to Artemis, Heracles, and Achilles.[67] Temples marked both headlands flanking the Euxine mouth of the Thracian Bosporus; and halfway down the strait other sanctuaries capped the promontories of Hermes and Heracles, which received the violent impact of the current rebounding from the Asian side.[68] At the southern end, where northbound vessels met the full force of current and etesian wind, several temples marked the elbow of the Asian coast at Calchedon;[69] and the opposite headland of Byzantium was crowned by sanctuaries to Poseidon, Athene, Artemis, Aphrodite, and Heracles, all within three hundred yards of its hilly extremity, while altars of Achilles and the twin Dioscuri lay near the city of By-

[67] Pliny, *op. cit.*, IV, 26; Strabo, *op. cit.*, XI, 2 : 6–8; E. H. Minns: Scythians and Greeks, Cambridge, 1913, pp. 21–23.

[68] Polybius, *op. cit.*, IV, 39, 43, 44; Strabo, *op. cit.*, VII, 6 : 1.

[69] Xenophon, *op. cit.*, I, 3.

zantium.[70] This diverse group of deities represented the patron gods of the various seamen who frequented the busy port of the Golden Horn.

The Euboean Sound Route

The Hellespontine wind made perilous sailing at the entrance to the Malic gulf and the Euboean sound, where the rocky headlands

FIG. 23—Plan of the port of Budrum (Halicarnassus); inset, the ancient city. Compare Figure 24. (From Comte de Choiseul-Gouffier: Voyage pittoresque de la Grèce, Paris, 1782, Vol. 1.)

showed their teeth to approaching vessels. All these headlands therefore, were capped with temples or altars to Artemis, Thetis, Athene, and Zeus the Savior.[71] The Euboean sound itself is protected from the Hellespontine blast by the long mountainous island of Euboea, which forms a breakwater and wind shield. But the Euripus or narrows of the sound, which contracts to two hundred feet between Aulis and Chalcis, was dreaded by ancient seamen because of the tidal rips which formed here and shifted four times in the twenty-four hours (Fig. 32); and also because of the squalls dropping from the high massif of Mt. Dirphys (5725 feet)[72]. With adverse winds and tide it was impossible to pass these narrows. Here under the lee of "Aulis rising high above the waves," was a little harbor where vessels were wont to await a change of wind and current.[73] In this port of refuge

[70] Pauly-Wissowa, article "Byzantion."

[71] Sophocles, *Trachiniae*, 238, 752–754, 993; Diodorus Siculus, *op. cit.*, XI, 12; Strabo, *op. cit.*, IX, 5 : 22; Apollonius of Rhodes, *op. cit.*, I, 568.

[72] Livy, *op. cit.*, XXVIII, 6.

[73] Euripides, *Iphigenia in Aulis*, 122, 157.

Agamemnon and the Greek fleet, assembled for the campaign against Troy, were detained for weeks by head winds; and here finally, at the sanctuary of Artemis, Agamemnon sacrificed his daughter Iphigenia, that the goddess might facilitate their departure.[74] The altar of Artemis that crowned this little promontory became a place of sacrifice for later military ventures setting forth across the Aegean from the shores of Greece.[75] The pagan sanctuary has disappeared; the

FIG. 24—View of the port and citadel of Budrum (Halicarnassus). Compare Figure 23. (From Choiseul-Gouffier, Voyage, Vol 1.)

perils to navigators have persisted; a little chapel to St. Nicholas watches here today over the fate of the seamen.

ROUNDING THE SOUTHERN PELOPONNESUS

The Hellespontine wind carried the current from the Hellespont southwestward across the Aegean. Side by side they swept around the southern end of Euboea and of Attica, where Poseidon from both rocky heights overlooked the stormy passage, and with undiminished force maintained their way southwestward to merciless Malea. This headland forms the eastern prong of the mountain trident of southern Peloponnesus, the other two being Taenarum and Acritas. All three flanked the course of vessels seeking Italy and the western Mediterranean, and all were buffeted by conflicting winds. Acritas on the west was swept by gales moving southward out of the Adriatic. All

[74] *Ibid.*, 90, 178, 350, 1450, 1540–1580.
[75] Xenophon, *op. cit.*, III, 4 : 3–4.

three at times were exposed to the southwest wind from Africa, and all knew the squalls sweeping down from the highland of Arcadia. They felt "the south wind warring with the north" described by Horace, the surf breaking on their hidden reefs, and the spume of the sea on their rocky fronts. Hence, besides the promontory sanctuaries, there were altars to Apollo Acritas, to the Malean Apollo, and to

FIG. 25—Map of the vicinity of Miletus showing various stages in the silting up of the gulf between Miletus and Priene by the Maeander. Compare Figure 26. (From Choiseul-Gouffier, Voyage, Vol. I.)

Taenarian Poseidon in the city of Sparta, where prayers preceded every Laconian venture on the deep.[76]

But Malea was worst of all. "The blasts of whistling winds and swollen waves as huge as mountains," which drove the returning Menelaus south to Crete,[77] have continued to give the cape a bad name for storms and heavy seas through all time. The Spartan fleet that set out for Syracuse in the Peloponnesian War was caught by the Hellespontine wind off the cape and swept south to Africa. The fleet of Belisarius in 533 A.D., bound from Constantinople to Carthage, rejoiced to round Malea in calm weather.[78] Therefore the ancient seamen safeguarded themselves by establishing here four sanctuaries. A temple to Apollo Epidelius flanked the promontory on the east:[79] sanctuaries to Apollo,[80] Zeus, and Athene[81] capped the bold spurs

[76] Pausanias, *op. cit.*, III, 12 : 5, 8.
[77] Homer, *op. cit.*, III, 287–290.
[78] Procopius, *De bello vandalico*, III, 13 : 5–7.
[79] Strabo, *op. cit.*, VIII, 6 : 1.
[80] Thucydides, *op. cit.*, VII, 26.
[81] Pausanias, *op. cit.*, III, 22 : 10; 23 : 1.

of the cape itself, while from the summit of Cythera a temple to Aphrodite, or Astarte of Phoenician origin, looked down on the boisterous channel between island and headland (Fig. 11).[82] The Parnon range, which tapers off southward to form Malea, is a ridge of bare, black limestone, 2600 feet high, dropping steeply to the surf at its base. A sheer cliff, 200 feet high, supports the last narrow ledge, on which are now two chapels and a hermit's cave.[83] Malea still retains its terrors.

FIG. 26—The ruins of Miletus and the course of the Maeander. Compare Figure 25. (From Choiseul-Gouffier, Voyage, Vol. I.)

It overlooks a busy sea lane, dotted by the sails of sponge fishermen in quiet weather, as by the boats of the Phoenician purple gatherers in ancient times. Ocean liners plow past, oil tankers and grain ships from the Black Sea hold their course westward; but in stormy weather steamers and fishing smacks alike are held up for days.

The ancient east-west sailing route may be traced by these promontory temples, set up like milestones at every port of call, all the way from Cyprus past Crete and Malta to the Pillars of Hercules. When vessels left the shelter of the Asia Minor coast on their sunset voyage, they sailed along the leeward side of Rhodes past Lindus to escape the north wind; but they encountered it again till they succeeded in passing the templed promontory of Salmonium at the eastern extremity of Crete, a perennial point of danger.[84] Here the Apostle Paul met rough sailing on his voyage to Rome in the autumn of 40 A.D. His vessel found easy going along the sheltered southern coast of Crete and was lucky in having a gentle south breeze for rounding

[82] Herodotus, *op. cit.*, I, 105.
[83] Philippson, Der Peloponnes, pp. 175–176.
[84] Apollonius of Rhodes, *op. cit.*, IV, 1693.

the templed promontory of Lissus,[85] because it was mid-October and far too late even for a grain ship from Egypt to be abroad in the Mediterranean. So the inevitable happened: the wind circled around to the northeast and the tempestuous Euroclydon, counterpart of the Italian bora, swept over the Mt. Ida range (8200 feet) of Crete into the Bay of Phaestus (modern Bay of Messara). It pounded Paul's

FIG. 27—Plan of ancient Syracuse. The city was situated on the island of Ortygia, which, connected with the mainland by mole and bridges, formed a promontory protecting the Great Harbor. Note the temples to Minerva and Diana. Compare Figure 28. (From T. S. Hughes: Travels in Sicily, Greece, and Albania, London, 1820, Vol. 2.)

vessel and drove him with the Greek crew for nine days westward to Malta.[86] It was generally an involuntary voyage, captained by the arbitrary god of the winds, that carried an ancient vessel across the open sea from Crete to Malta. These were dangerous waters. The promontory protecting the bay of Malta was crowned in Cicero's time by a temple of Juno, very ancient, very rich, and held in peculiar veneration;[87] and another headland was dedicated to Melkart from the early Phoenician appropriation of the island.[88]

THE ISTHMIAN ROUTE TO ITALY AND SICILY

To avoid Malea and shorten the voyage between the Saronic and Corinthian gulfs, ancient passenger vessels and small freighters with

[85] Philostratus, *Life of Apollonius of Tyana*, IV, 34.
[86] Acts of the Apostles, 27 : 7–14.
[87] Cicero, *In Verrem*, V, 46.
[88] Ptolemy, *Geography*, IV, 3, 37.

valuable cargoes took the isthmian route across Greece, making the four-mile transit of the Isthmus by the diolcus, or roller tramway, maintained by Corinth. The importance of this passage, despite the isthmian tolls, is attested by the promontory temples flanking the route. Westbound vessels issued from the narrow Corinthian Strait between two temples of Poseidon, crowning the Rhium and Antirrhium promontories (Fig. 30),[89] and turned thence northward along the coast

FIG. 28—View of Syracuse. Compare Figure 27. (From "Atlante geografico e illustrativo della corografia dell' Italia," [Florence, 1845?], Vol. 4.)

past the dreaded Leucadian headland to Corcyra, whence they crossed the Strait of Otranto to Italy.[90] They struck land near Hydruntum (Otranto) where a temple of Mercury welcomed them from afar; or, sailing twenty miles farther south, they reached the promontory tip of Italy. Its summit was crowned by the temple of Athene Leucadia, which Aeneas saw on approaching the Italian shore.[91] This spot is now occupied by the church of Santa Maria di Leuca, or the Madonna in Finibus Terrae. Only the platform of the old temple remains, but in the limestone cliff is a grotto containing ancient petitions of passing sailors to Jupiter Optimus.[92]

From this point the vessels steered across the broad opening of the Gulf of Tarentum to the Lacinian promontory, site of a temple to Hera, who was apparently successor to an earlier goddess, native to the place. This was once the most hallowed temple of Magna Graecia

[89] Thucydides, *op. cit.*, II, 86; Pliny, *op. cit.*, IV, 3.
[90] Vergil, *op. cit.*, III, 275, 506–508; Thucydides, *op. cit.*, VI, 42–44.
[91] Vergil, *op. cit.*, III, 530–532.
[92] A. J. C. Hare: Cities of Southern Italy and Sicily, London, 1883, p. 326.

and held annually a great panegyric.[93] Today a solitary column, twenty-six feet high, rises from the massive substructure and gives the headland the name of Capo delle Colonne,[94] while near by is the church of the Madonna del Capo, to which young girls go barefoot in procession every Saturday. Fifteen miles to the south is a second promontory, once sacred to Castor and Pollux.[95] The destination of most Greek ships coming from the Gulf of Corinth was Sicily, whose

FIG. 29—View of Corinth from the citadel, looking towards the Gulf. The rocky promontory in the background runs from Mt. Gerania (on the right) westward to terminate in the headland now called Cape St. Nicholas. (From Stackelberg, La Grèce, Vol. 1.)

rich grainfields and pastures helped to supplement the meager food supplies of the old Greek cities. The eastern coast of Sicily was studded with templed promontories marking the entrances to the colonial ports,[96] while sanctuaries of Poseidon and Artemis on the Pelorus headland safeguarded the perilous Strait of Messina.[97]

All three corners of triangular Sicily endangered navigation, and all were sites of famous temples. The Pachynum promontory at the south, *imbriferos Pachynos*, with its Apollo sanctuary was swept by north winds streaming down the Strait of Messina and also by southwest gales from the Atlas Mountains.[98] It was therefore the scene of frequent shipwrecks. The most famous promontory shrine of perhaps the whole Mediterranean capped the northwestern angle of Sicily, where the massive headland of Eryx rose to the height of

[93] Livy, *op. cit.*, XXIV, 3; Diodorus Siculus, *op. cit.*, IV, 24 : 7; Aristotle, *De mirabilibus auscultationibus*, 96.

[94] Hare, *op. cit.*, pp. 349–350.

[95] Pliny, *op. cit.*, III, 15.

[96] Thucydides, *op. cit.*, VI, 3; Cicero, *In Verrem*, IV, 53; Appian, *Bello civili*, V, 12 : 109.

[97] Diodorus Siculus, *op. cit.*, IV, 5, citing Hesiod; Strabo, *op. cit.*, VI, 1 : 5.

[98] Ovid, *op. cit.*, XIII, 725; Macrobius, *Saturnalia*, I, 17 : 24; Polybius, *op. cit.*, I, 37, 54.

2463 feet and made a second Malea.[99] On its level summit the early Phoenician colonists established their goddess Astarte and filled the grove about her temple with doves that figured in her worship. To the Greek colonists of Sicily she was Aphrodite of Eryx; she became Venus of Eryx when the Romans conquered the island and embellished her shrine.[100] At present her sanctuary site is occupied by the cathedral of Our Lady of Eryx, patron saint of the Sicilian sailors, Stella Maris of the Sicilian sea (Fig. 31). Hither pilgrims come from all parts of Sicily to make their offering for safe voyages, and they admire the doves which still wing their way from tree to tree in the surrounding grove. The sacred site has never changed, nor the human need; only the divine encumbent has assumed a different name and different guise.

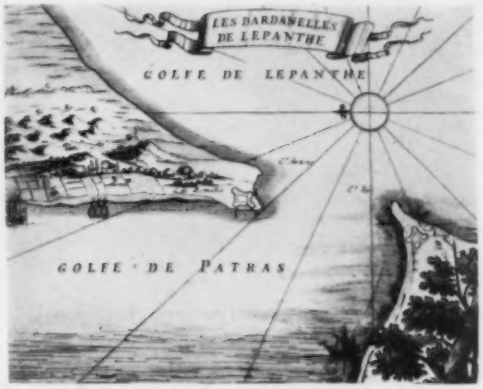

FIG. 30—Map of the Strait of Lepanto. The Venetian forts crowning the narrows, in antiquity the points known as Rhium (south) and Antirrhium (north), are on the site of temples to Poseidon. (From O. Dapper: Naukewrige Beschryving van Morea, Amsterdam, 1688.)

SACRIFICES TO PROMONTORY GODS

The promontory gods who were expected to rescue men from dire peril were appeased by offerings of cattle and even of human lives. Artemis in her more primitive forms was propitiated by human sacrifices, like that of Iphigenia at the temple of Aulis. This barbarous phase of her cult tended to appear as a heritage from Astarte, wherever the Tyrians established their factories or fishing stations. It characterized the sanctuary of Artemis on the Parthenium promontory of southwestern Crimea among the Taurii, who cast shipwrecked seamen from the cliff of the headland as offerings to Artemis of the deep;[101] for the Taurii were fishermen and pirates, preying upon Greek vessels trading with the Crimean coast. The cult was either indigenous, belonging to a native Parthenia, or virgin goddess, on whom the Artemis worship was grafted; or it was borrowed from the Tyrians who maintained their purple-fishers' camp on the coast.[102] Certainly it was not borrowed from the Greeks. In the drama of Euripides the translated Iphigenia, who officiated as priestess in the gloomy Parthenian temple,

[99] Polybius, *op. cit.*, I, 55; Vergil, *op. cit.*, V, 759–773.

[100] Freeman, *op. cit.*, Vol. I, pp. 277–280, 548–551.

[101] Pomponius Mela, *op. cit.*, II, 3; Herodotus, *op. cit.*, IV, 103; Strabo, *op. cit.*, VII, 4 : 2; Pliny, *op. cit.*, IV, 26.

[102] Euripides, *Iphigenia in Tauris*, 262–264.

voiced all the repugnance of the Hellenic mind to the barbarous features of the cult.[103]

Yet similar features characterized the cult of Apollo on the Curias promontory in southwestern Cyprus, long under Phoenician influence. There anyone who touched the altar of the god was cast into the sea to

FIG. 31—Cathedral of Our Lady of Eryx on the Promontory of Eryx, successor of a temple of Astarte and of Venus of Eryx.

propitiate the deity.[104] But the most dramatic scene was yearly enacted at the temple to Apollo on the Leucadian promontory of southwestern Leucas (Fig. 6). The forces of air and sea multiplied the dangers of rounding this headland, which thrust out a rocky spur six miles in length and 2000 feet in height, rising in sheer cliffs of white limestone right across the path of the Adriatic winds. This was "the

[103] *Ibid.*, 34–41, 380–405.

[104] Strabo, *op. cit.*, XIV, 6 : 3; Thucydides, *op. cit.*, III, 94.

far projecting rock of woe," known and dreaded by ancient Greek and Roman sailors.[105] In order to avoid it the sand and boulder reef that connected Leucas with the mainland was pierced as early as 500 B. C. by an artificial canal. But waves and currents repeatedly barricaded the opening and forced vessels to round the Leucadian promontory. Here again the exigencies of the case demanded human sacrifices,

FIG. 32—The narrow and dangerous channel between Aulis and Chalcis. (From Stackelberg, La Grèce, Vol. 2.)

which evidently figured in the cult of the Leucadian Apollo from the gray dawn of history. Strabo gives us the story. Once a year on the feast day of the god a criminal who had forfeited his life was cast from the top of the cliff into the sea. But the moral refinement of a more cultured age raised a protest against the barbarity. Hence, before the victim was thrown over the cliff, he was provided with crude Daedalian wings and numerous doves were attached by strings to his person, in order that the fluttering of their pinions might break the force of his fall. Below on the water a group of expectant fishermen waited in their boats, ready to pick up the victim, if he should survive the fall, and carry him as an exile out of the country. One can imagine the scene—the bold, gleaming cliffs, the temple of Apollo on the summit, down below the white-winged fishing boats, with their sturdy sailors looking upward for the appearance of the victim, awe and fear and hope depicted on their countenances. But the Leucadian promontory was merciless in a storm; the god up there held no sinecure.

[105] Strabo, *op. cit.*, X, 2 : 8–9.

Though one hundred and seventy-five of these templed promontories have been identified, a few stormy headlands which by every law of geographical probability should have been sanctuary sites have not proved true to type. The Mt. Garganus promontory (3460 feet), the spur of Italy, though exposed to the dread bora sweeping down the Adriatic, held minor local shrines but none to a sea god. Notorious as Malea was Cape Caphereus "the Devourer," a rocky prong jutting out from the southeast coast of Euboea into the teeth of the Hellespontine winds. It was the graveyard of the ancient Aegean; its funeral chants sound through all classical literature.[106] But it had no saving shrine. Its evil genius was represented by Nauplius, whose misleading fires lured to destruction the Greek heroes returning from the siege of Troy.[107] The few who were washed ashore on Caphereus found only a cave, containing an altar and image of Dionysus, but they welcomed the warming gift of the god of wine.[108]

[106] Euripides, *The Troades*, 90–91.
[107] Propertius, *Poems*, III, 7 : 39; Euripides, *Helena*, 1129; Ovid, *Tristia*, I, 1, 83; V, 7, 36.
[108] Pausanias, *op. cit.*, II, 23 : 1; IV, 36 : 6.

INISHMORE: AN OUTPOST ISLAND*

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FIG. 1.—The Aran Islands, "mere bare ribs of rock," lying off the west coast of Ireland.

IN our world of today highly developed systems of transportation and communication, added to differences of resource, topography, and climate, have given rise to an industrial civilization based on exchange. Our production is largely production for sale. This all seems so much a part of our surroundings that we seldom stop to consider that such has not always been the case and that it is by no means universally true now.

Many regions enter little into trade because they have little or nothing to offer to the outside world: they make up a surprisingly large percentage of the earth's surface. The dry deserts, the cold deserts, the rocky wastes, and areas shut off by mountains or other barriers from communication with the outside, support small, self-sufficient populations in which the rest of the world is not economically interested. An example of such an area on a small scale is Inishmore, or Arannore, the largest of the Arans, a small group of islands lying off the mouth of Galway Bay on the west coast of Ireland. Before entering into a description of the island and its people, it would be well to note that the Aran islands are not in an out-of-the-way corner of the earth but within a day's journey of modern Dublin and but eleven hours farther from London. Lack of resources alone keeps Inishmore from progress.

The photograph, Figure 2, shows an islander, a little less than the average in height but otherwise typical. He is clothed from the neck down entirely in products of island manufacture. The nautical cap on his head is a relic of a trip in a Norwegian herring schooner, but every other article of clothing is native. His woolen sweater, trousers, and socks are made from the fleece of island sheep. The moccasins, or "pampooties," are made from the hide of a cow raised on the island and bound together with strips cut from the same hide. He paused in his fishing to pose rather self-consciously for this picture.

* Read before the twenty-third annual meeting of the Association of American Geographers at Philadelphia, December 28–30, 1926. The writer spent two weeks on Aranmore in the summer of 1926.

The Island Itself

What is the environment that produced this man? The island is about nine miles long and two broad in its widest place. It runs roughly northwest to southeast. Its surface is of an almost bare limestone rising from the level of the sea to an elevation of three or four hundred feet in the interior (Fig. 3). The lines running hither and yon without any apparent reason are fences of the loose limestone rocks of the surface piled in an attempt to clear the little fields to some small extent of the stones which litter them. The first impression is of barrenness, and it is not belied by a closer inspection. There is not a tree on the island, and only a feeble growth of brush in some of the sheltered and better-watered spots.

The east coast (Fig. 4) is low and approachable if your boat is not too large. For this reason all but about 100 of the 1800 people of the island live in this section. Sand has drifted in here and helps to give the island what little naturally cultivable land it has. The land rises rather rapidly to the central backbone of the island in a broken series of terraces (Fig. 5) almost entirely bare of soil and of vegetation. The limestone is cracked and seamed to relatively great depths, and there are no surface streams: it is a typical karst. Westward the surface falls rather sharply in a long line of steep cliffs standing from 100 to 300 feet high facing the Atlantic (Fig. 6).

At the census of 1911, the last for which details are available, there were 1779 people on this island in an area of 12 square miles. This is a density of 148 to the square mile which is greater than that for any of the states of the United States except the five manufacturing states of Rhode Island, Massachusetts, Connecticut, New Jersey, and Pennsylvania. It exceeds by a good deal that for rich agricultural states like Illinois, Indiana, or Iowa. With its scarcity of agricultural land, such a population density means a low standard of living. The area has lost population slightly in every census period.

Fishing

This is the land in which our islander is trying to make a living. The first consideration is, of course, food. The sea lies all about him and is teeming with fish—sometimes. He catches herring, mackerel, bream, and rockfish during the summer. If the run is small, they are eaten sparingly fresh, the largest part dried, and some salted for use in the winter.

Fishing is not a business involving schooners, large crews, and expensive tackle. It is a dangerous, laborious expedition in the light canoes or curraghs (Fig. 9) almost identical with those in use when the Romans first came to Britain. The only change is the substitution of canvas for cowhide as covering. In these frail craft four men will

brave high waves when the fish are running well. Their oars are mere slats with no breadth to the blade. The islanders say that with these there is less danger of "catching a crab" while rowing in a choppy sea, and their boats are so light as not to need heavy oars.

Fishing by hand lines or small nets from the boats or from the rocks on the shore is the only method open to these people, for there is not enough capital available in the islands to purchase larger boats. It can be easily imagined that these primitive methods do not produce much of a surplus above the food needs of the people except when the fish are running exceptionally well and command a high price on the mainland.

Even if the fish are running well, however, starvation may face the fishermen because of weather too rough for them to venture out in their little boats or too wet to allow for drying of the fish before they spoil. The islanders are now complaining that British and Belgian steam trawlers are spoiling their fishing grounds.

FIG. 2—An inhabitant of Inishmore clothed, with the exception of the cap, entirely in products made on the island. Note the primitive moccasins.

AGRICULTURE AND STOCK RAISING

Life on Aran is not all fishing, however: the islander contributes to his food supply by agriculture and stock raising. His agriculture is of the intensive, small-field variety, for the areas where any soil is present are scarce and small, and the omnipresent limestone rocks make difficult the work of clearing a field (Fig. 7). In fact, land is so scarce that some has actually been made. Sand is carried in baskets from the beaches of the eastern coast and spread on the bare rock: this

FIG. 3

FIG. 4

FIG. 5

FIG. 3—A section of Inishmore from the sea. Note the limestone fences dividing the fields.
FIG. 4—The low, sandy leeward coast. The cemetery is in a dune, crop land being too valuable.
FIG. 5—Looking across the island toward the north. The maze of fences and the large areas of rock outcrop are much in evidence.

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FIG. 6

FIG. 7

FIG. 8

FIG. 6—Looking up the west coast. The cliffs range from 100 feet to 300 feet in height.
FIG. 7—Agricultural land: the white patch in the distance is bare limestone.
FIG. 8—Typical island dwellings built of limestone thatched with rye straw.

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is covered with a layer of seaweed and then another layer of sand and another of seaweed. After a few years this compost has become amalgamated enough to raise a scant crop of potatoes.

Potatoes are the principal crop. They have the advantage of growing well in the limey soil and giving a relatively large yield from a small acreage. The thin soil, however, becomes parched if it does not receive rainfall on the average every three days. There is hardly

FIG. 9—The curragh, or seagoing canoe, of the Arans. It is common to the west coast of Ireland and is a descendant of the cowhide-covered boat of the ancient Britons.

ever a surplus of potatoes, and if there is it is usually fed to the pigs. Rye is the only other considerable crop. The yield is only sufficient to furnish seed for the next year. The straw is used for thatching, and its cultivation gives the potato land a rest. Small fields of beets and turnips are planted occasionally, largely to supplement the winter pasture of the stock.

Such is the simple and rather difficult system of agriculture. Land is too scarce to permit of much crop rotation: fish and seaweed are the only fertilizers.

It is only in stock raising that there is any surplus from the land. Pasture is found in scattered areas on the thin soil of the central ridge. There are seldom more than three or four cattle to a family. Each maintains two milch cows and raises what calves its pasturage will allow. Even in the most prosperous homes beef is too valuable to appear often on the table. The beeves are sold on the mainland and frequently form the only cash income of the family. The climate is mild enough so that cattle are left outdoors the year round, the more sheltered pastures being kept for the winter. The only barns are for horses and the storage of tools and fishing equipment.

Pigs are kept by nearly every family, as they are cheap feeders. Potatoes, turnip tops, and the scant table scraps are the principal feeds. Pork is the meat oftenest seen on the island tables though

seldom enough at that. There are almost no sows. The young pigs are bought on the mainland in the spring and raised on the island. When grown they are either eaten or shipped back to Galway for sale. Sheep are raised on the pasture that is too poor for the cattle. Most families own a few, and they provide wool for the almost universal manufacture of homespun. Their carcasses give an occasional feast of mutton.

FIG. 10—A pile of dried seaweed ready to be burned to produce the "ore" from which iodine is extracted.

SHELTER AND FUEL

The source of the clothing of the island has already been described. Only the most difficult of articles to manufacture, or those for which no materials are at hand, are bought from the outside.

The demand for shelter is rather easily met (Fig. 8). The climate, though wet, is never severe. The surface is littered with limestone suited to building purposes, and the local lime makes fine mortar and whitewash. The small rye fields supply thatch for the roofs, which are renewed yearly. Rafters, doorsills, and furniture have to be made of expensive imported lumber. Often the furniture in the poorer cottages is made of driftwood from some wreck on the rugged western coast.

Fuel is one of the few vital elements not in large measure supplied by local materials. As has already been indicated, there is not a tree on the island, and the brush is scarce and small. The barren limestone has no turf covering to yield the principal fuel of the mainland.

It is here that the need of a cash crop is most keenly felt. Before the small surpluses of fish, cattle, hogs, or kelp can be applied to the purchase of even condiments or tools, the year's supply of peat must be obtained from the mainland. This hard-earned fuel supply is eked out with cow dung, very carefully saved and plastered on the stone walls to dry. Indeed, many families burn nothing but cow dung for cooking all summer, saving the precious turf for the heating needs of the winter, when a fire must be kept burning continually.

The tools needed in such an existence are few. The boats are made on one of the islands, but the wood and canvas have to be imported. They are patched until they look like Lazarus' coat, and when the canvas wears thin the natives slap on an extra coat of tar and, without the least hesitation, set out on a night's journey to sea, following the fish. Fishing tackle, hardware, and the simple agricultural tools are imported and are, therefore, very carefully preserved.

FIG. 11—The gate to the inner fort at Dun Aengus from the inside. This dry stone has been standing for about 20 centuries. The wall is about 25 feet thick at the base.

INDUSTRIES

The only industry in the island which is carried on solely with a view to a production for sale is the drying and burning of kelp, a source of iodine (Fig. 10). The seaweed is laboriously gathered from the rocks and spread out to dry, not always a successful process because of lack of sunshine. Once dried it is burned in pits to the clinker-like mass in which it is marketed. Four tons of seaweed must be gathered to make one ton of the material of commerce. The continuous labor of three or four men for over twelve hours is needed to stir the burning kelp of each pit filling—a half ton. The price in 1926 was between six and seven pounds sterling, or $25.00 to $30.00 a ton. The return is so small that the amount of kelp produced varies inversely with the ease of catching fish, as the latter yields larger return per unit of labor.

Another industry which has recently grown to be of some importance to the islands is the entertainment of the few visitors who come there during the summer. Most of these are school teachers from the mainland who come here and spend a month brushing up their Gaelic, as this is the almost universal language of the islands.[1] Some are wandering archeologists or students of literature who wish to visit the antiquities in which the islands abound.

[1] See note "Irish and Welsh Speech in the British Isles," elsewhere in this *Review*.

Antiquities

Perhaps the most interesting of these relics is Dun Aengus (Fig. 11) an old fort standing on the northwestern cliffs and suggesting the last outpost of an outpost kingdom. It has often been described by archeologists.

Many of us still remember the sense of almost inaccessible remoteness that attached to "the Aras of the Sea." All who have visited the spot feel the "repellent

Fig. 12—The *chevaux-de-frise* of jagged limestone on the approach to the fort of Dun Aengus.

attraction" of the gigantic precipice and the swirling abyss over which the fort is so airily poised. Then there is the pathos—no less of the legend that made it the refuge of a doomed and hunted race than of its own inevitable destruction—that invested the broken grey walls on the farthest edge of the old world.[2]

The fort consists of a series of three walls forming three roughly concentric semicircles with the arcs extending toward the east and the back to a cliff that drops 350 feet to the Atlantic. The diameter of the outer circle is about 900 feet and that of the inner one about 150 feet. As one progresses from the outer to the inner walls, these works grow higher and thicker until the wall of the inner circle is 25 feet in thickness, made up of the limestone which lies loose all over the surface of the island. The stones are laid together without any mortar, but the work is in a fine state of preservation. The best authority places the date of construction of this fort at about the first century of the Christian era. The builders were rather canny military architects in their way, too, as is shown by the rude *chevaux-de-frise* of rough limestone protecting the approach.

One of the interesting sights of the island is the large number of crude rock monuments (Fig. 13) to the departed, erected along the roads, often miles from the place where the body lies in the dune cemetery on the eastern side of the island.

[2] T. J. Westropp: A Study of the Fort of Dun Aengusa in Inishmore, Aran Isles, Galway Bay: Its Plan, Growth, and Records, *Proc. Royal Irish Acad.*, Vol. 28, 1910, Sec. C., pp. 1–46; reference on pp. 1–2.

The Inhabitants

The metropolis of the island is the village of Kilronan where the post office, the two stores, the two public houses, and the church are located. This village has also the only wharf on the three islands; only the smallest steamers can tie up to it. Synge describes it as so changed by the fishing industry developed by the Congested Districts Board that it now resembles any fishing village on the west coast of Ireland.[3]

Fig. 13—Memorials to the dead. The deceased may have been lost at sea or buried in the cemetery several miles away, but these monuments line the roads.

General health conditions are not of the best, although some of the people live to an extended age. The writer attended a funeral there at which the deceased was eighty-four years old, and his godmother was one of the chief mourners. In such a damp climate tuberculosis, pneumonia, and rheumatism are the principal diseases. The recent influenza epidemics naturally wrought great havoc.

The people are sturdy, industrious, hospitable, and honest. They speak Gaelic among themselves, but most of them have English for the stranger. There is seldom any crime among the islanders except the occasional manufacture of poteen or moonshine whisky. Little need be added to Synge's summary:

> It is likely that much of the intelligence and charm of these people is due to the absence of any division of labour, and to the correspondingly wide development of each individual, whose varied knowledge and skill necessitates a considerable activity of mind. Each man can speak two languages. He is a skilled fisherman, and can manage a curagh with extraordinary nerve and dexterity. He can farm simply, burn kelp, cut out pampooties, mend nets, build and thatch a house, and make a cradle or a coffin. His work changes with the seasons in a way that keeps him free from the dulness which comes to people who have always the same occupation. The danger of his life on the sea gives him the alertness of the primitive hunter, and the long nights he spends fishing in his curagh bring him some of the emotions that are thought peculiar to men who have lived with the arts.[4]

[3] J. M. Synge: The Aran Islands, Boston, 1911.

[4] *Ibid.*, pp. 153–154.

REGIONS OF INTERIOR-BASIN DRAINAGE

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[With separate map, Pl. II, facing p. 414]

THE extent and hydrography of the land areas in the world served by interior basin drainage are of interest to all students of earth science. The physiographic relations of a third of the lands would be changed if precipitation everywhere found its way to the oceans, as is the normal condition in most inhabited regions. In the physical economy of the globe one may consider as two separate domains the regions of interior and the regions of oceanic drainage. It is convenient to describe each of these two great regions by a single word: we may term through-flowing, or ocean, drainage "exoreism" (ex-o-rē-ism, from the Greek ἐξ, out, and ῥεῖν, to flow), interior basin drainage "endoreism" (en-do-rē-ism, from ἐν, in, and ῥεῖν).[1] In this paper we shall attempt to define the extent of the endoreic, or interior-basin, domain and explain its causes. The deserts are *par excellence* the domain of interior-basin drainage, or endoreism. But they present a particular case where run-off is nil and for which the term "areism" is proposed (a-rē-ism, from α, privitive, and ῥεῖν).

Early Work on the Problem

Richthofen[2] distinguished between the peripheral and the central regions of Asia, the latter marked by an arid climate and interior-basin drainage. The first and, up to the present, the only attempt to represent cartographically the extent and disposition of interior-basin drainages is in Berghaus' Physikalischer Atlas, Plate No. 16, 1891, which has been reproduced in divers other works. John Murray, in a paper read before the Royal Society of Edinburgh on Jan. 17, 1887, gave the first estimate of the inland drainage area.[3] He placed it at about a fifth of the land surface, or 11,486,350 square miles, a figure only a little less than that of the arid regions (12,200,000 square miles), or regions of annual rainfall under 10 inches. His calculation was made on an equal-area projection on which were superlaid the

[1] Emmanuel de Martonne: Aréisme et Indice d'aridité, *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 182, 1926, pp. 1395–1398.

[2] Ferdinand von Richthofen: China: Ergebnisse eigener Reisen und darauf gegründeter Studien, (5 vols., Berlin, 1877–1912), Vol. 1, p. 7.

[3] John Murray: On the Total Annual Rainfall on the Land of the Globe, and the Relation of Rainfall to the Annual Discharge of Rivers, *Scottish Geogr. Mag.*, Vol. 3, 1887, pp. 65–77.

boundaries of the interior-drainage basins according to Berghaus. In his admirable monograph on Lake Bonneville[4] G. K. Gilbert, also following Berghaus, gives values for the continents thus: Australia, 52 per cent; Africa, 31; Eurasia, 28; South America, 7.2; North America, 3.2.

Penck's "Morphologie,"[5] so rich in numerical estimates, gives figures for the "Binnengebiete" as 22.1 for the continents as a whole, or 29,900,000 square kilometers, of which Europe has 1.6; Asia 12.6; Africa 9.6; Australia 4; North America 0.9; South America 1.2. All these have been calculated on the basis of the Berghaus map: there appear to have been no attempts to improve on this generalization. Penck and Murray note the zonal disposition of the interior drainage and its connection with climate. Neither concerns himself with the Caspian Sea. G. K. Gilbert alone seems to have envisaged the complexity of the problem. Since the publication of Berghaus' map our knowledge of the earth's surface has progressed enough to permit of more precise representation of the endoreic domain and of delimitation of the areic domain—a distinction that has not been attempted before.

Method of Work

From the standpoint of hydrologic records it is unfortunate that regions of interior-basin drainage are in general but little inhabited. The great modern states lie in regions of normal or through-flowing drainage. The United States is the chief exception: the extent of the interior-drainage basins of the West is exactly known. We are also fortunate in having figures for the basins of the old Russian Empire from the Baltic to the Pacific.[6] With such data in hand, however, the question is not always solved. It often happens that in the higher parts of a basin there is flow, permanent or temporary, which does not attain base level. The hydrographers who measure the area of each basin are not concerned with this distinction, for us essential. The inverse case is also known. A river abundantly fed from its sources may in its lower course traverse a desert, which should be included in the endoreic or perhaps the areic domain. The Nile is an alien feature of the Libyan Desert; it does not receive a drop of water therefrom but, on the contrary, loses a great part of its volume. The same is the case with the Sir Darya and Amu Darya in Russian Turkestan. Our predecessors have not taken account of these facts. The entire Nile basin is included in oceanic drainage on Berghaus' map and in the calculations of Murray, Gilbert, and Penck. Whence arises a serious

[4] G. K. Gilbert: Lake Bonneville, *U. S. Geol. Survey Monograph No. 1*, 1890.

[5] Albrecht Penck: Morphologie der Erdoberfläche (2 vols., Stuttgart, 1894), Vol. 1, p. 189.

[6] Jules de Schokalsky and A. de Tillo: Superficie de la Russie d'Asie, avec les bassins des océans, des mers, des rivières et des lacs, St. Petersburg, 1905, French text, 1907. See also Jules de Schokalsky: La comparaison des mesures de superficie, de l'Asie Russe et de ses bassins, *Atti X Congr. Internaz. di Geogr., Roma*, 1913, Rome, 1915, pp. 642–651.

error in the results as a whole. Thus even where the surfaces of the hydrographic basins have been exactly delimited and measured we have been obliged to repeat a part of the work; but in most cases the results had to be built up basin by basin through original studies.

The accompanying map of the endoreic and areic regions has been the object of a series of studies prosecuted during some ten years by the students at the Institut de Géographie of the Sorbonne under the direction of M. de Martonne. Maps of the continents or parts thereof have been drawn up on scales ranging from 1 : 1,000,000 to 1 : 6,000,000. Use has been made of all cartographic documents in the collections of the Institut, which numbers about 35,000 sheets, in particular of the sheets of the millionth map of the world and of all the maps covering considerable territory on this scale. The work, however, might not have been accomplished even yet if, after five years of interruption (1914–1919), there had not been available the devoted collaboration of L. Aufrère, who has had charge of the editing of the world map on the scale of 1 : 20,000,000. This work has included complete and detailed revision, all doubtful points being referred to the original documents.[7]

The difficulties arise in part from the unequal value of the source material, in part from the indefiniteness inherent in the limits themselves. The boundary between the endoreic and the exoreic regions can be drawn without hesitation, granted the accuracy of the maps used; it is different, however, with areism. Only on maps of scale not less than 1 : 100,000 with the detail and precision of regular surveys can the boundary of areism be recognized; and it is a zone rather than a line, a zone fluctuating from year to year with variations in climate.

In principle we include in the areic regions all areas that do not originate rivers that reach the sea either directly or through flow into some other stream. A river crossing the region without rising therein does not change the areic character, as was pointed out above. Regions of intermittent streams are not included in the areic domain provided the streams flow at some time in every year, if only for a few days. The maps do not always enable us to decide this point: yet on scales larger than the millionth, if well executed, they give certain unmistakable indications if degradation of the hydrographic network is in progress. A stream channel that is not utilized will not keep continuity of gradient; it broadens in section, a succession of hollows appears, obstacles such as a barrier of dunes choke the valley. Such characters are easily observed in the lower courses of great wadis of

[7] In consequence of this revision the figures differ somewhat from the earlier calculations given in: Emmanuel de Martonne and L. Aufrère: Extension du drainage océanique, *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 180, 1925, pp. 939–942, and Emmanuel de Martonne: Extension des régions privées d'écoulement vers l'océan, *Compte Rendu Congr. Internatl. de Géogr.*, Cairo, 1925, Vol. 3, pp. 25–50. The diagrams of percentage of areism and endoreism also have been based on a new method which better permits comparison with the index of aridity: zonal values have been transformed to linear values.

the Sahara descending from the Atlas or the Ahaggar[8]. Among extreme forms of degradation may be noted the torrential character of stream flow in the desert observed on the mountain borders, as in the Arabian desert east of the Nile and in the Tassili of the western Sahara. The torrent beds are well enough defined, but often they remain without water for several years. An occasional heavy rain launches a flood known as *séil*,[9] similar to the *lave* of the alpine torrents, which carries all before it but lasts only a short time and generally does not reach the end of the valley. Such a régime is revealed on a good map by the absence of the regular network of stream channels. The effects of heavy downpours are shown in sheet flood erosion as described by McGee[10] and in excessively broadened river beds passing to the form of the wadi. The piedmont waste descending towards the center of the basin is furrowed by dry discontinuous channels. Such inundation may extend over immense distances at the foot of the mountains enclosing interior basins. Good examples may be seen on certain sheets of the West of the United States and southern Algeria.

Even in a rapid survey one cannot fail to notice areas thickly sprinkled with unconnected lakes. It is an imperfect form of areism, which we may term "humid" areism, frequently seen in plains where a rainy season occurs too short to permit organization of drainage. Such may be noted in Senegal and the Sudan, where one speaks of "winter lakes," in Turkestan, on the edge of the Karroo, etc. The number and extent of these bodies of water vary from one season to another; so that the reconnaissance maps give very different pictures of the country according to the time when they have been made.

It is obvious that the work on our map has necessitated a rational interpretation of cartographic documents of very unequal value. To supplement the maps use has been made of meteorological data, of scientific results of explorations, and of travel narratives.

The influence of the nature of the ground has also to be considered. Limestones and permeable sands, sandstones, even recent basalts, loess in sufficient thickness may produce artificial effects as in the karst of Dalmatia. Permeability of soil really deserves a special study in both arid and semiarid regions. Central Yucatan, where rainfall reaches 800 millimeters, would probably enjoy a temporary run-off, though probably not a regular run-off, if the subsoil were not a limestone.

The Calculation

Measurement of the surface areas has been made according to the method that gives the highest degree of accuracy within the scope of

[8] E. F. Gautier: The Ahaggar: Heart of the Sahara. *Geogr. Rev.*, Vol. 16, 1926, pp. 378–394.
[9] W. F. Hume: Geology of Egypt, Vol. 1, Survey of Egypt, Cairo, 1925, p. 85.
F. Foureau: Ma mission de 1893–1894 chez les Touareg Azdjer, Paris, 1894.
[10] W J McGee: Sheetflood Erosion, *Bull. Geol. Soc. of Amer.*, Vol. 8, 1897, pp. 87–112.

the problem. Our original on the scale of 1:20,000,000 has been carried out on a base map by Eckert, which has a complete network of meridians and parallels by degree units. We counted for each continent the number of whole units (trapeziums) and estimated the value of the fractions in each latitudinal zone in the endoreic and areic domains. The total obtained was multiplied by the area of a trapezium by degrees given by tables for the spheroid. Adding the values by zones gave figures by continents, hemispheres, and for the globe as a whole.

This method, formerly employed by Schokalsky for measuring the basins of the Russian Empire, appears to us well designed for all areal measurements on the continents and especially for such as concern the whole of the globe. It avoids the corrections which must be applied to planimetric methods or measurements by weight. It is applicable, furthermore, to maps on other than the equal-area projection; for the only surfaces directly measured are very small, fragments of a degree trapezium, and here it is a matter of the proportion and not a direct measure. The method has the additional advantage of giving figures by zones of latitude permitting the examination of several interrelations of phenomena, particularly of climate.

Results of the Study As a Whole

According to our map the entire surface having interior-basin drainage covers nearly 42,000,000 square kilometers, to be precise 41,838,000, rather more than a quarter (27 per cent) of the total land surface of the globe, a third (33 per cent) if the polar lands are excluded, as we shall exclude them from the following discussion. These figures surpass previous estimates. The difference is not due simply to a greater precision in execution but to a more exact definition of the interior-drainage basins.

Of the 41,838,000 square kilometers without drainage to the sea (endoreic domain) 27,991,000 only appear to be entirely without run-off; in other words the areic domain accounts for 17 per cent of the total land surface, 23 per cent if the polar regions be omitted.

We may now stop to consider the importance of these results. It is significant that on 23 per cent of the continents evaporation exceeds precipitation and that on 11 per cent of the remainder the rains are insufficient to assure flow to the ocean under the present conditions of relief; so that on 33 per cent of the surface the meteoric waters, abstracted for the most part from the surface of the sea, do not return there. It must be concluded that extension or reduction of endoreism would have as consequence a lowering or a raising of the level of the sea and thus cause important changes in the shore lines. Precipitation is not abundant in regions of interior drainage; the index of run-

off, zero in the areic domain, rarely exceeds an average of 10 centimeters in the endoreic domain. Nevertheless with a surface of 14,000,000 square kilometers there would still be a volume of 1400 cubic kilometers escaping to the oceans each year—a value corresponding to a lowering of sea level of 0.47 meters a century. There is a unity in the earth's hydrography which justifies, in a measure, the expression hydrosphere.

From the point of view of continental morphology the endoreic and areic domains exhibit abnormality. The law of the common base level is not applicable to a third of the lands. The proportion would be still greater if exception were made of those parts of America and Eurasia where the ground is frozen to a depth; perhaps it would attain 40 per cent. As the endoreic domain is unable to export its waste, the interior basins tend to fill up with progressive raising of the base level offset in some instances, of course, by exportation of desert dust to extradesert regions.[11] This has a bearing on sea level, difficult, however, of numerical expression. All available estimates of denudation are based on observation in the exoreic regions. L. W. Collet[12] gives 57 millimeters as the mean lowering of surface per century for the northern slopes of the Swiss Alps. Reducing this to one-third, a total of 3 cubic kilometers of material a century is kept back from marine sedimentation by the fact of interior-basin drainage. The raising of sea level that would result from complete removal of waste to the sea is small in comparison with that which would be produced by the return to the sea of the endoreic waters (3/100), yet it is not negligible. Finally, if isostatic equilibrium is not an idle expression, the displacement of material of erosion must affect it; and one cannot doubt that it would be sensible to a change in the extension of endoreism. The surface area of terrigenous sediments is estimated at 73,000,000 square kilometers; the 3 cubic kilometers of sediments remaining in the interior basins would, on this surface, be equivalent in a century to a layer 17 meters thick, disregarding the effect of settlement. In weight, and accepting Collet's figure of 1.5 for mean density of sediments, it would represent a load of 4.5 milliard tons, or 26 tons per square meter.

Variation According to Latitude

The method that permits us to calculate the total area of the endoreic and areic domains gives us a means of showing the variations of their latitudinal extent calculating the proportion for each degree

[11] Siegfried Passarge: Die Kalahari: Versuch einer physisch-geographischen Darstellung der Sandfelder des südafrikanischen Beckens, Berlin, 1904.

W. M. Davis: The Geographical Cycle in an Arid Climate, *Journ. of Geol.*, Vol. 13, 1905, pp. 381–407.

Erich Kaiser: Die Diamentwüste Südwest-Afrikas, 2 vols., Berlin, 1926.

[12] L. W. Collet: Les lacs: Leur mode de formation, leurs eaux, leur destin, Paris, 1925.

zone. Table I gives these numerical values graphically shown in Figure 1. The irregularities of the curve need not prevent us from arriving at some general conclusions. Disregarding anomalies such as rise from the varying and dissimilar distribution of land and water in northern and southern hemispheres, the general trend of the curve is clear enough: oceanic drainage, or exoreism, dominates in the high latitudes and in the equatorial zone; its minimum extension in both hemispheres is about the tropic but is better displayed in the northern hemisphere. The continental hemisphere also is that in which endoreism is most extended, having about three-quarters of the domain (32,000,000 square kilometers).

The curve of percentage of areism is close to the zero line on 25 degrees in low latitudes, it returns there from the 55th parallel in the northern hemisphere and the 50th in the southern hemisphere. Its ups and downs in the southern latitudes between the 40th and 50th parallels are as erratic as those of the endoreic curve and need not claim our attention here.

The explanation of the variations of percentage in the endoreic and areic regions according to latitude must be sought for in the climatic factor. We have already noted the vital importance of precipitation and temperature. The zonal means of these phenomena have been deduced from meteorological maps and may be compared with the percentages of endoreism and areism by calculating in round numbers the percentage for corresponding parallels.[13] It appears that the curve of endoreism follows that of temperature in the temperate zone, that of rainfall in the warm zone. This is as would be expected; in middle and high latitudes the variations of temperature are much greater than that of the rains, whereas in low latitudes the temperature variations are small. The extent of interior drainage appears to be reduced to a minimum when mean annual precipitation exceeds 1200 millimeters, whatever the temperature, and when the mean temperature falls to 0° C., however deficient the precipitation. Yet it should be noted that the relations are not the same in the two hemispheres. Furthermore, the minimum towards the equator does not correspond with a rainfall maximum: it lies at about the 10th parallel in the southern hemisphere.

The Index of Aridity

If the action of temperature is preponderant in the high latitudes and that of precipitation in the low latitudes these two influences act everywhere, and it appears desirable to find some means of expressing their combined function. After several attempts we believe a satisfactory combination has been found, and we call it the "index of

[13] Martonne, Traité de Géographie physique, 4th edit., Vol. 2, 1926, p. 940.

TABLE I—EXTENT OF ENDOREIC AND AREIC REGIONS BY LATITUDINAL ZONES

(Expressed by area in 1000 square kilometers and as percentage of total land area)

LATITUDE	NORTHERN HEMISPHERE				SOUTHERN HEMISPHERE			
	ENDOREIC		AREIC		ENDOREIC		AREIC	
	AREA	PER CENT	AREA	PER CENT	AREA	PER CENT	AREA	PER CENT
0	74	7	61	6	43	4	28	3
1	120	13	74	8	55	5	39	3
2	135	15	74	8	49	5	18	2
3	135	15	61	7	59	5	10	1
4	107	11	61	6	66	6	6	1
5	98	10	49	5	49	5	12	1
6	159	16	61	6	29	3	10	1
7	195	18	55	5	45	4	8	1
8	218	19	36	3	33	3	9	1
9	250	23	54	5	15	2	14	2
10	261	25	78	8	8	1	8	1
11	289	31	91	10	4	0.5	4	0.5
12	370	38	147	15	18	2	11	1
13	437	42	326	31	41	5	13	1
14	612	56	447	41	68	7	19	2
15	653	59	511	46	111	11	23	2
16	707	64	640	55	124	12	31	3
17	776	63	712	58	241	24	91	9
18	821	62	771	58	382	38	170	17
19	843	64	770	59	453	47	266	27
20	859	65	803	61	522	51	375	37
21	858	61	803	61	567	55	333	32
22	863	59	801	55	530	51	268	26
23	836	57	768	52	551	55	311	31
24	822	57	788	54	539	56	370	39
25	859	56	799	52	501	56	354	40
26	847	54	764	49	507	58	328	37
27	931	58	828	52	504	58	323	37
28	924	57	769	48	488	58	406	48
29	954	58	743	45	494	61	398	50
30	1040	61	751	44	483	63	386	50
31	920	57	642	40	379	54	279	40
32	813	52	422	27	265	44	183	30
33	654	44	329	23	212	40	161	31
34	606	40	292	19	158	44	96	27
35	593	39	188	12	127	44	80	27
36	592	39	188	12	119	44	55	20
37	686	46	309	21	89	33	30	11
38	740	50	393	27	48	23	19	9
39	690	46	461	30	57	42	29	11
40	729	47	538	34	56	44	28	22
41	729	48	452	30	46	34	18	13
42	700	46	468	31	50	39	36	28
43	743	47	547	35	45	41	43	39
44	720	46	572	36	44	42	33	32
45	709	44	582	36	35	37	11	12
46	736	45	553	34	25	34	20	27
47	636	37	413	24	34	48	30	42
48	505	29	257	15	36	52	28	40
49	400	24	179	11	28	44	24	38
50	298	18	134	8	16	35	12	26
51	245	15	85	5	3	6	3	6
52	259	16	83	5	1	3	1	3
53	304	19	103	6				
54	317	22	115	8				
55	293	21	98	7				
56	202	15	12	1				
57	185	14	10	1				
58	165	13	4	0.3				
59	112	9	3	0.2				
60	43	3						
61	9	1						

aridity," Ar $= P:(T + 10)$, T representing the mean annual temperature in degrees centigrade and P the annual precipitation.[14] The establishment of an arbitrary zero at $-10°$ C. is based on two considerations: endoreism is unknown in regions having an annual mean temperature lower than this; in most of these regions the ground remains frozen at a depth the year round, giving rise to abnormal conditions of circulation.

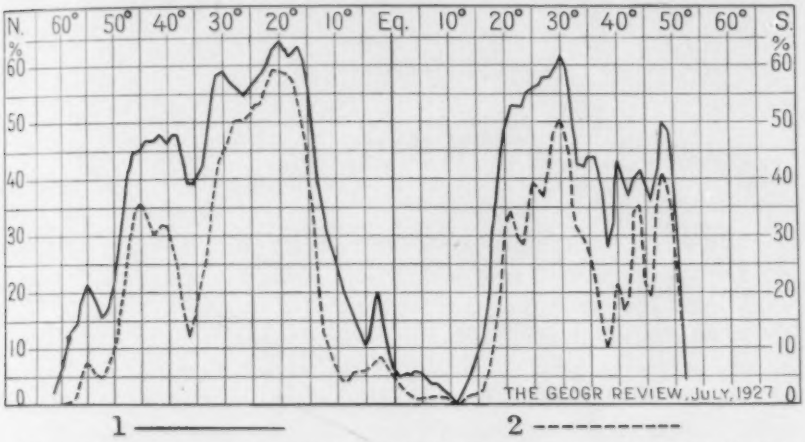

FIG. 1—Areas of the endoreic and areic domains in relation to the total area of the lands by degree zones of latitude. The endoreic domain is shown by a solid line, 1; the areic domain by a dashed line, 2. Compare Table I.

We still have to set forth a correction of T calculated by the meteorologists, for we apply it to continents alone. T in our formula represents a zonal mean newly calculated for this purpose after Hann's isotherms.[15]

A glance at Figure 2 shows us that the curve of the index of aridity follows faithfully that of endoreism and areism. It has the same points of inflexion, save the equatorial minimum, and values comparable in the two hemispheres (excepting the high latitudes of the southern hemisphere). The arid zone is farther from the equator in the southern hemisphere and is more reduced. It is at about the 30th parallel in the southern hemisphere that the maximum of endoreism as well as of areism is found, whereas in the northern hemisphere it lies at about the 20th parallel; and these latitudes correspond to minimum values of the index of aridity. As a whole we can say that exoreism is at a maximum for values of Ar above 35 and at a minimum for values below 20; the limit of areism corresponds about to 10.

[14] Emmanuel de Martonne: Aréisme et indice d'aridité, *Comptes Rendus de l'Acad. des Sci., [de Paris]*, Vol. 182, 1926, June 7, pp. 1395–1398.

[15] Julius von Hann: Atlas der Meteorologie, forming Part III of Berghaus' Physikalischer Atlas, Gotha, 1887.

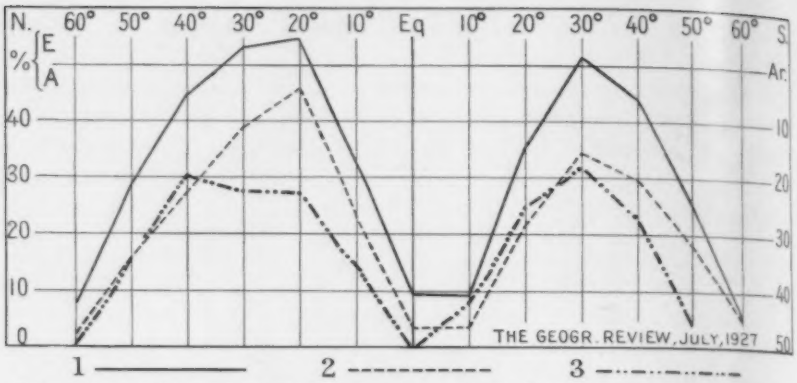

FIG. 2—Extent of the endoreic and areic domains compared with the index of aridity by 10-degree latitude means. Endoreism is shown by solid line, 1; areism by a dashed line, 2, with scale of percentages on the left: the index of aridity is shown by dot-and-dash line, 3, scale on right.

The value of the index of aridity can be checked by calculations for a certain number of points in critical areas: in such case it is understood that the mean temperatures are not reduced to sea level. In the areic regions we invariably find indices below 10, reaching scarcely 1 or 2 in the most typical deserts. Thus in the Sahara 6 at Laghwat, 2 at El Golea, 5 at Tozeur; in Russian Turkestan 3 at Khiva, 5 at Merv; in the center of Australia 4 at Strangways Springs; in the deserts of the west of the United States 2 at Yuma; in those of South America 2 at Lima and 1 at Copiapó. Between the limits of areism and endo-

TABLE II—PERCENTAGE OF ENDOREISM (E) AND AREISM (A) COMPARED WITH INDEX OF ARIDITY (AR)

(By 10-degree means)

LATITUDE	WORLD AS A WHOLE			EASTERN OLD WORLD			WESTERN OLD WORLD			NEW WORLD		
	E	A	AR	E	A	AR	E	A	AR	E	A	AR
60 N.	8	2	50	7	5	55	20	0	35	1	0	75
50 "	28	16	34	45	32	25	30	6	40	7	2.5	47
40 "	44	27	20	65	40	15	41	25	21	17	7.5	30
30 "	53	39	17	35	19	25	80	65	5.6	26	18	27
20 "	54	46	17	8	5	36	86	75	7.6	18	13	28
10 "	33	23	35	0	0	48	49	34	31	2.5	1	41
0	9	3	51	0	0	67	18	6	39	0	0	58
10 S.	9	4	42	12	4	53	16	6	36	4.5	2.5	45
20 "	35	22	25	53	31	15	28	17	20	21	13	38
30 "	51	34	18	72	52	12	23	17	17	39	21	32
40 "	44	30	27	30	26	47	(5)	(4)		49	28	21
50 "	25	18	46							32	22	43

reism the indices vary between 10 and 20; for example in Asia, Samarkand 14, Semipalatinsk 15, Peshawar 10; in North America, Salt Lake City 17, Winnemucca 11; in South America, Salta 17.

These examples bring us to an attempt to show the value of the index of aridity on a map for the continents as a whole. About 200 stations conveniently chosen permit the drawing of curves for indices of 5, 10, 20, 30, and 40 (Fig. 4). Comparison with the map of interior-basin drainage shows in general a remarkable correspondence between the limits of areism and the 5 Ar line which appears to enclose the true deserts. The curve of 20 is less faithful to the limit of endoreism which is often determined by relief, notably in Asia. But beyond the index of 30 drainage is everywhere organized to the ocean with the exception of the Volga, whose waters flow to the greatest inland sea, the Caspian.

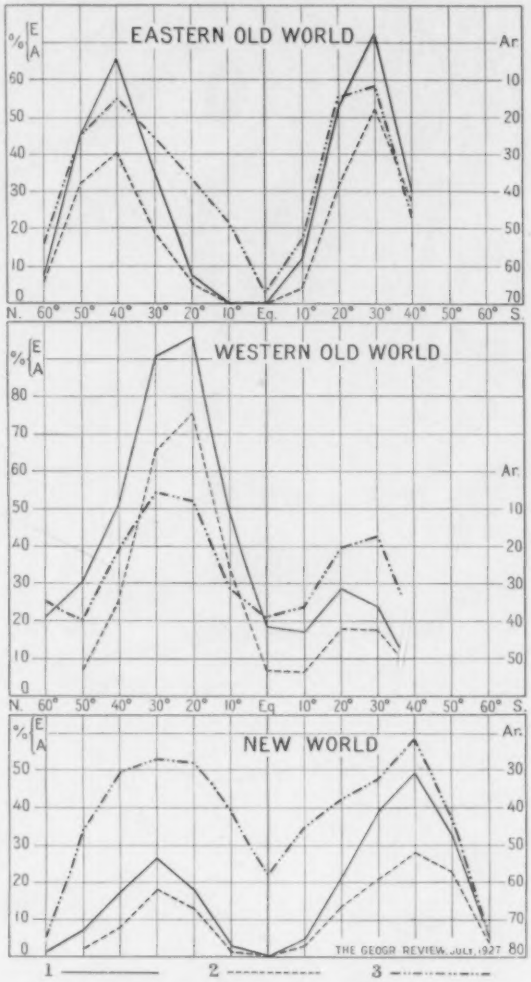

FIG. 3—Extent of the endoreic and areic domains compared with the index of aridity for the three continental spindles. Endoreism is shown by solid line, 1; areism by dashed line, 2, with scale on left: the index of aridity is shown by dot-and-dash line, 3, with scale on right. Compare Table II.

It appears, then, that we have in the index of aridity a climatic function of great value for explaining conditions of drainage. Its geographical significance is still broader. Such a combination of temperature and rainfall explains the character of the vegetative cover much more adequately than rainfall alone. It seems that indices below 5 characterize the true deserts from the botanical as

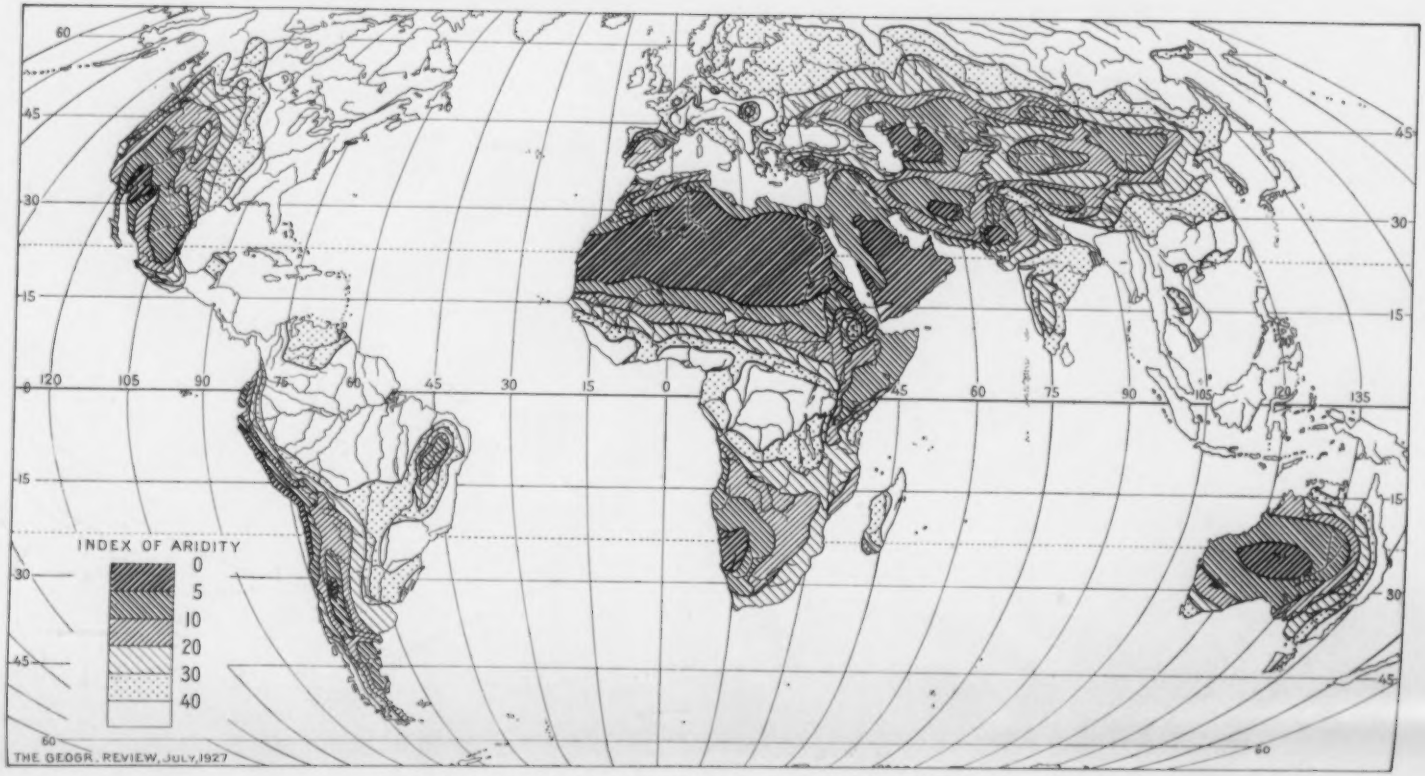

FIG. 4—World map of the index of aridity. Scale approximately 1 : 160,000,000.

well as the hydrographical point of view; indices about 10 correspond with the dry steppes; those of 20, more or less, to the prairies; above 30 forest vegetation tends to predominate and gains complete control of the soil where the index exceeds 40 provided that the temperatures are not too low. The relation with agricultural possibilities may also be noted. No cultivation is possible without irrigation where the index of aridity is below 10; between 10 and 20 is the domain of dry farming. Applications of the index of aridity have been developed elsewhere.[16] It has the advantage[17] of requiring only two sets of meteorological data whose values are known for almost the entire globe.

Figures for the Continents[18]

We shall now consider the distribution of interior-basin drainage according to the major divisions of the land surface of the world. We may first group the continental masses into three spindles: (1) the New World, the Old World divided into (2) Western and (3) Eastern sections by the Urals, the Caspian Sea and Persian Gulf, and the 50th meridian (Table II and Fig. 3).

The New World is the best drained; outside of the tip of South America no zone has more than 40 per cent interior drainage. Accordance with climatic conditions as synthesized by the index of aridity is marked. The Western and Eastern spindles of the Old World present contrasts. The former exhibits in the northern hemisphere the highest proportions of endoreism and areism in the neighborhood of the tropics and the lowest about the 40th parallel, whereas the Eastern spindle shows the greatest extension of oceanic drainage in the low latitudes. In this spindle the great extent of areism outside the tropics in the southern hemisphere (in Australia) is noteworthy. Clearly it is the Western spindle of the Old World that is responsible for the asymmetry of the curve of endoreism for the world as a whole, this spindle being the only one where the equatorial minimum lies at 10° S. This peculiarity is not reflected in the index of aridity, but we may inquire as to whether we are sufficiently well informed on the climate of equatorial Africa.

North America is the best-drained continent, the endoreic and areic domain being there reduced to 10 per cent, 2,136,000 square kilometers. This is not surprising, considering the high values of the index of aridity for all latitudes. Climate, then, is the chief cause here.

[16] Emmanuel de Martonne: Une nouvelle fonction climatologique: l'Indice d'Aridité, extract from *La Météorologie*, October, 1926.

[17] Compare D. Szymkievicz: Études climatologiques, *Acta Soc. Botan. Poloniae*, Warsaw, 1923, 1925. Compare also Dr. Paul Hirth's recent attempt at combining temperature and rainfall, "Die Isonotiden," in *Petermanns Mitt.*, Vol. 72, 1926, pp. 145–149, discussed (with maps) by Mark Jefferson in the April number of the *Geogr. Rev.*, pp. 335–338.

[18] Lack of space prevents inclusion here of a section by L. Aufrère, discussing individually the more important basins of interior drainage. In a special reprinting of the paper this section is included as an appendix and may be obtained on request.—Edit. Note.

THE GEOGR. REVIEW, JULY, 1927

But it should be noted that nearly half the continent lies north of the 45th parallel, that is in a zone where endoreism is almost unknown. The endoreic domain is scarcely more extended than that of the areic and is strictly limited to the west. This is not only because of the orographic structure, which is as unfavorable to run-off to the Pacific as it is favorable to the Atlantic: the climate is as dry in the one as it is humid in the other. The map shows the index of aridity dividing the United States into two halves, the one to the east where Ar is everywhere above 30 and even exceeds 40 between the Mississippi and the Atlantic, the other below 30 and even below 20 over the entire extent of the dry Rockies and the Great Basin.

It is perhaps surprising that South America is not so well drained as North America, in spite of the enormous rainfall of the great Amazon basin—so admirably organized, it would seem, for regular run-off. The per cent of endoreism (14) is raised by the aridity of the continent south of 30° S.

South America, however, is better drained than Europe, where one expects a better organization of the run-off. If the endoreic domain occupies 24 per cent of Europe (2,205,000 square kilometers) areism is almost unknown. In reality the anomaly is due to the northward extension of the Volga basin, tributary to the Caspian. The greatest part of this basin has indices of aridity comparable to those of France (Samara, 27; Kazan, 30), but the slope leads the waters into an interior basin too broad and deep for overflow and enclosed by areic plains (Astrakhan, 7).

Asia, Africa, and Australia are continents where drainage is less perfect. A high proportion of their areas is in latitudes about the tropic; and their structures are massive, without coastal articulations as in western Europe, without great open plains like the Amazon and Mississippi basins. Interior depressions due to faulting or warping are numerous and everywhere create systems of slopes converging towards closed basins that could drain towards the ocean only if the climate were very humid.

Australia has the record for endoreism, 64 per cent, and for areism, 43 per cent. It is the only continent traversed centrally by the tropic. Its relief is nowhere sufficiently important to favor precipitation save on the eastern coast; but if the Australian Alps favor the littoral over which they look it is to the detriment of the plains stretching westward.

Nearly half of Africa drains towards the ocean: the endoreic domain amounts only to 52 per cent, the areic to 40 per cent. The reason is that a large part of that continent lies in the equatorial zone. The Congo basin is apparently a closed basin that has overflowed. The case is the same with the Zambezi and the Niger. Among the tectonic depressions of eastern Africa those lying in sufficiently rainy

regions have maintained their outlets; the others are isolated, their centers being occupied by lakes, some of them saline.

Asia is the most interesting continent hydrographically. The percentage of interior-basin drainage is lower than that of Africa, although it includes 14,847,000 square kilometers, or 35 per cent of the total endoreic domain. All monsoonal Asia has oceanic drainage with indices of aridity above 40. The great plains of Siberia for the

TABLE III—AREA AND PERCENTAGE OF ENDOREIC AND AREIC REGIONS BY MAJOR DIVISIONS

(Areas in 1000 square kilometers)

REGION	ENDOREIC		AREIC	
	AREA	PER CENT	AREA	PER CENT
Europe	2,205	24	452	5
Asia	14,847	35	9,935	24
Africa	15,223	52	11,771	40
Australia	4,920	64	3,309	43
North America	2,136	10	1,070	5
South America	2,507	14	1,454	8
Northern Hemisphere	32,386	34	22,139	23
Southern Hemisphere	9,452	28	5,852	17
World	41,838	33	27,991	23

most part have regular drainage, having indices of over 35 and 40. The principal area of endoreism is found in latitudes where elevation is very great. The reason is to be sought in the numerous tectonic depressions whose size demands a humid climate for the maintenance of through drainage, whereas the climate is dry because the mountains cut off the rainy winds. Observations are lacking for the calculation of indices of aridity in the greater part of these regions; we only know that it falls below 10 in Russian Turkestan (Merv, 5; Kasalinsk, 6; Irgis to the north of the Aral, 11).

SOME EXCEPTIONS TO LATITUDINAL ZONING

Having examined the most striking feature of distribution of interior-basin drainage we may now inquire into some of its numerous irregularities. Along the equator oceanic drainage is the rule, as interior drainage is along the tropic. Yet there are exceptions. The most important is in eastern Africa. From Eritrea to Nyasa stretches a belt where endoreism and even areism prevail. Meteorological data are lacking, but the vegetation bespeaks true aridity. In northeastern Brazil is an arid region more limited, it is true, but similar in situation

to that of the steppes and deserts to the east of Lake Victoria. The extension of aridity to the tip of the Somali country and the seaboard is not matched anywhere, and a really satisfactory explanation has not yet been offered.

The western borders of the continents do not escape aridity in the equatorial zone. South America offers the most striking example with the coast desert of Peru. That the cold Humboldt Current is a contributary cause has been confirmed by the recent incidence of the rains of 1925 and the weakening of the current.[19] South Africa offers an analogous case in the aridity that extends from the mouth of the Orange River almost to the Congo and is associated with the cold Benguela Current.

It is along the tropic that the greatest stretches of endoreism and areism are found: but these zones, which correspond to indices of aridity below 10 or even 5, are not continuous. The monsoonal domain of southeastern Asia has an index of aridity above 40. The Antilles, southeastern North America, and other tropical and subtropical eastern seaboards are also humid.

Beyond the 30th and 40th parallels humidity becomes the rule on the western coasts and endoreism is thrown back into the interior. The southern extremity of South America is divided into a narrow, very wet littoral section on the west and an arid section covering all Patagonia on the east. In North America the prairies show patches of endoreism up to the 55th parallel. In Eurasia areism exists at least to 56° or 57° in the west Siberian plains. The polar limit of areism is systematically advanced under the continental climate in these flat alluvial plains. That of endoreism is advanced still further by exceptional conditions of relief: the waters of the Volga are abundant enough to reach the ocean did not the slope lead them to the greatest closed basin created by deformation on the earth's surface and lying, furthermore, on the borders of a great areic region. With this exception the index of aridity explains the systematic irregularities in the zonal distribution of interior basin drainage. These may be summarized thus: aridity limited to the borders of the equatorial masses of the continents, especially to the western littoral in the southern hemisphere; general aridity along the tropics with the exception of the eastern slopes; westward extension of aridity in the subtropical zone; aridity confined to the continental interiors towards the poleward limit of areism. Departures in detail are to be ascribed to the direct influence of relief or of geological structure on stream run-off.

Considerations of conditions as they are today will not explain everything. Relief is affected by crustal movements still in progress in places, and everywhere erosive forces are at work. Nor is climate

[19] R. C. Murphy: Oceanic and Climatic Phenomena Along the West Coast of South America During 1925, *Geogr. Rev.*, Vol. 16, 1926, pp. 26–54.

constant. Hence hydrographic adaptation to conditions as we see them is not perfect. Headward erosion of the systems draining to the ocean threatens the independence of the interior basins, particularly in the endoreic regions where local base level is being raised by sedimentation if not by lake formation. In Africa the basins of the Nile, the Niger, and the Zambezi exhibit the conquest of exoreism over endoreism. Lake Chad is threatened by the Niger. In the rainy season the Benue, a tributary of the Niger, is already tapping the waters of the Logone, tributary of the Shari.

The case of the Nile is curious, for its lower course is through an areic region. The basins of the equatorial region overflow and yield water in abundance, so that erosion of the rock barriers forming the cataracts continues. Probably it was during the humid phases corresponding to the Quaternary glaciations that captures of the interior basins of the upper Niger and the upper Zambezi took place. The Niger was then reinforced by the entire network of fossil wadis of Tafassasset. Erosion of the Victoria Falls is still in full swing on the Zambezi. The Niger has only rapids, no falls, in its course.

As regards evolution of the present drainage in northern Africa French geographers and geologists have rightly protested against Grund's hypothesis of the extension of interior drainage.[20] All indications point to headwater erosion in the basins of the high Algerian-Moroccan plateaus by Atlantic and Mediterranean rivers. But it is probable that the most appreciable gains were made during the humid periods of the Quaternary.

In Asia many conquests of oceanic drainage over endoreism also date from the Quaternary. The Ob captured the Black Irtish and the Zaisan Nor, the Amur and the Liao Ho invaded Manchuria, the Hwang Ho and the Brahmaputra penetrated, the one the Ordos, the other Tibet. Nor has postglacial aridity compromised the situation, thanks to these powerful watercourses. It is certain that communication by the Uzboi existed between the Aral and Caspian Seas during the Quaternary when the level of the former sea was higher: it is even probable that there was an outlet from the Caspian to the Sea of Azov by the Manytsch. The Volga is threatened with capture by the Don: so far it has escaped, owing to the sinking of the water surface of the Caspian, 30 meters below sea level, a lowering which in turn is due to the enormous evaporation under a desertic climate.

These are a few examples of the fluctuating fortunes in the strife between oceanic and interior drainage since the Quaternary. It may be asked if annexation to the exoreic domain always constitutes an advantage. It may be considered so if it occurs in a region anciently endoreic where return to normal conditions leads to the exportation of waste, to the establishment of a regular drainage network, and perhaps

[20] E. F. Gautier: Sahara algérien (Missions au Sahara, Vol. 1), Paris, 1908.

to an amelioration of climate, access of winds from the oceans being facilitated. It is not certain that there is climatic or even physiographic advantage in the case of an areic region. The retention of waters as a lake in an arid region, as Chad, Lob Nor, the Aral Sea, is favorable to life; evaporation renders the air less dry, infiltration creates ground-water resources. The Kalahari appears to have lost by the conquests of the Zambezi and the Orange. It is a fact that the life of Bornu depends on the Chad, and Colonel Tilho[21] considers that a great danger threatens these territories in the imminent capture of the Shari by the Benue.

The development of interior-basin drainage, like other geographical facts, cannot be explained by present conditions alone. Important changes have occurred in the recent past, are in operation now, or are being prepared for in the future. They are of interest to us for the light they throw on the relations of the physical phenomena to which the face of the earth is due. They may have economic consequences to which no one can remain indifferent.

[21] Jean Tilho: Sur l'ordre de grandeur des variations de profondeur et d'étendue du Lac Tchad, *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 180, 1925, pp. 1233–1236.

Idem: Les variations du Lac Tchad, *Bull. Assn. de Géographes Français*, No. 9, May, 1926.

The American Geographical Society of New-York.

MAP OF INTERIOR BASIN DRAINA

By EMM. DE MARTONNE and L. AUFRÈRE

Guiana Highlands
Llanos
Cordillera de los Andes
Orinoco
Galapagos Is.
Tumbes Desert
Sechura Desert
Desert Plains of Peru
Desert Plains of Chile (Atacama Desert)
L. Titicaca
Puna
Pampas
Juan Fernandez
Patagonian
Falkland Is.
South Georgia
Ascension
St Helena
Desert of the Diamonds
Karroo
Sertão
Mato Grosso
GREAT CHACO
Amazon
Rio Negro
Madeira
Tapajoz
Tocantins
Paraná
Uruguay
Rio de la Plata
Congo
Areic regions
(without surface drainage)
Endoreic regions
(Interior basin drainage)
Exoreic regions
(throng-flowing drainage)
Scale
1 : 50 000 000
0 500 1000 2000 Km.

AP OF INTERIOR BASIN DRAINAGE

By EMM. DE MARTONNE and L. AUFRÈRE

The Geographical Review, Vol. XVII No. 3, 1927, Pl. 2.

0°
20°
40°
60°
80°
100°
120°
140°
160°
180°
60°
40°
20°
Spitsbergen
Novaya Zemlia
BARENTS SEA
NORWEGIAN SEA
NORTH SEA
BALTIC SEA
Dvina
Volga
Ural Mountains
Irtish
Ob
Yenisei
Lower Tunguska
Angara
Lena
Olenek
Indigirka
Verkhoyansk Mountains
Anadir
L. Baikal
Sayan Mts
Baraba Steppe
Watershed of the Steppes
Altai
ARAL SEA
L. Balkhash
Dzungaria
Mongolian Altaf
Kangai
Great Khingan
Amur
Sungari
Manchuria
DESERT OF THE GOBIS
Tien Shan Mts
TURKESTAN
Pamir
Kuniun
TIBET
Hindu Kush
IRAN
Himalayas
Punjab
Ganges
Brahmaputra
Salween
Mekong
Tonle Sap
Annamite Cordillera
Menam
Irrawaddy
Chindwin
Arakan Yoma
Sittang
Tenasserim
Andaman Is.
Nicobar Is.
Ceylon
Laccadive Is.
Maldive Is.
BAY OF BENGAL
GULF OF OMAN
PERSIAN GULF
RED SEA
Dahna
Ahqaf
Great Nefud
Syrian Desert
Euphrates
Tigris
Arabia
Libyan Desert
Fezzan
Ahaggar
Tanezrufft
Tibesti
Adrar
Adjuz
Air
Kiri
Enedi
L. Chad
Bahr el Ghazal
Nile
Blue Nile
Atbara
Abyssinia
Somaliland
Kir
Rudolf
Ubangi
Benue
Volta
Niger
Tell Atlas
Sahara Atlas
Western Erg
Eastern Erg
Tripolitania
Tunisian Desert
Algerian Desert
Syrtes
Cyrenaica
Libyan Erg
Sahara
Caucasus
CASPIAN SEA
Armenia
Anatolia
Taurus
Balkans
BLACK SEA
MEDITERRANEAN SEA
Pyrenees
Apennines
Alps
Carpathians
Rhine
Danube
Loire
Elbe
Vistula
Dniester
Don
Tisza
Po
Sea of Okhotsk
Sakhalin
Kurile Is.
Aleutian Islands
BERING SEA
Hokkaido
Hondo
Bonin Is.
Ryukyu Is.
Marianne Is.
Caroline Is.
Mindanao
Luzon
SEA OF JAPAN
YELLOW SEA
EASTERN CHINA SEA
SOUTH CHINA SEA
Hwang Ho
Yangtse Kiang
Si Kiang
Tsin-Ling-Shan
Tsaidam
Tarim
Qara Qum
Kara Kum
Qaidam Basin
Qaidam Nor
Qinghai Nor
Kuku Nor
Dzungarian Gate
Issyk Kul
Lake Van
Urmia
Caspian Depression
Kirghiz Steppe
Kara Kum
Kara Kum
Qara Qum
Qara Qum
Qara Q

I N D I A N

O C E A N

Ceylon

Maldive Is.

Seychelle Is.

Mauritius

Reunion

Comoro Is.

MADAGASCAR

Sumatra

Borneo

Celebes

Molucca Is.

Java

New Guinea

Ubangi

L. Rudolf

L. Victoria

Congo

Kasai

Tanganyika

L. Rukwa

Nyasa

L. Kirwa

Zambezi

Okavango

Kwando

Etosha

Makarikari

L. Ngami

KALAHARI

Limpopo

Desert of the Diamonds

Karroo

Great Australian Desert

Desert Basin

Warburton Dunes

Barkly Tableland

Karst of Georgina

Swan Coastal Basin N.W. Basin

Gascoyne

Gibson Desert

MacDonnell Ranges

Dunes

Victoria Desert

Dunes

L. Eyre

Eucla Karst

Eucla Basin

Darling

Murray

Eastern Highlands

Tasmania

New Zealand

Kerguelen Is.

0° 20° 40° 60° 80° 100° 120° 140° 160° 180°

20° 40°

Scale
1 : 50 000 000
0 500 1000 2000 Km.

Chief watersheds

Libyan Erg : Regions of dunes

Abbreviations .— M.D. = Mohave Desert. G.D. = Gila Desert. P.D. = Painted Desert. Bolson de M. = Bolson de Mapimi.

Imp. Dufrénoy, Paris.

SCRANTON AS AN URBAN COMMUNITY

Clifford M. Zierer

University of California at Los Angeles

[With separate map, Pl. III, facing p. 422]

YONDER, the noisy water . . . takes a white leap from one of the loveliest and loneliest nooks carved from the mountain, before it splashes on the busy wheel of the manufacturers, and after being used three or four times in its passage through the village, mingles with the waters of the Lackawanna below. . . . the landscape sprinkled with brown colored dépôts, car-shops, and Vulcan's works upon every side; . . . on their passage to New York; . . . the chaste, imposing churches, the long, white lines of public and private architecture contrasting finely with the deep green of the surrounding trees, tastily left for shade; . . . the trains of coal-cars, serpentine and dark, emerging from the "Diamond Mines," . . . the villages of Hyde Park, Providence, Dunmore and half a dozen little rosy buds of villages, standing like sentinels at the outposts about to be surrendered; . . . the neat farm-houses here and there nestling in some lovely meadow or half hid among the blossoms of orchards, and the background of the unshorn mountain swelling upwards from . . . the Lackawanna region, all make up a [most impressive] sight. . . . Nor is this all, as he looks into the bosom of "Capouse Meadow," his eye wanders over coal lands which, fifteen years before the completion of a railroad outlet north from the valley, could be purchased for fifteen dollars per acre, and which now are worth $800; and lots which then no respectable man was willing to accept as a gratuity, now readily bring from one to two thousand dollars![1]

Hollister's pleasant description is a picture of Scranton in the middle years of the last century, at a critical time in its history. The future was already forecast, a basis laid for the development that has made Scranton today a unique industrial community, the largest and most metropolitan of all the cities of northeastern Pennsylvania. In the present paper it is proposed to examine these characteristics and briefly to trace their growth.

Regional Setting

As regards its regional setting Scranton comprises a portion of the dense grouping of population[2] in the highly industrialized Lackawanna-Wyoming Valley, the boundaries of which correspond closely with the limits of the northern anthracite field. The coal field is a long and narrow canoe-shaped basin having an area of 176 square miles, a length of about 50 miles, and a width varying from one to

[1] Horace Hollister: Contributions to the History of the Lackawanna Valley, New York, 1857, pp. 132–133.

[2] See the map, Fig. 1, accompanying the article by C. E. Batschelet, "A Picture of Population Distribution in Pennsylvania" in this number of the *Review*.

six miles. On both sides the valley is hemmed in by even-crested mountain ridges. An almost continuous array of urban communities stretches from north to south along the entire length of the valley. In fact, more than a hundred square miles of the coal basin are included in incorporated cities and towns; and in traveling from one end of the valley to the other one is seldom outside the limits of some

FIG. 1—The northern anthracite field of Pennsylvania. Forest City marks the northeastern end and Shickshinny the southwestern end of the canoe-shaped basin. To the southwest of Scranton the boundaries of the coal basin correspond in general with the 1000-foot contour line, except that almost no coal lies to the west of the ridge extending between Plymouth and Shickshinny, nor do the beds extend into all the small tributary valleys. To the northeast of Scranton the 1500-foot contour line more nearly defines the boundaries of the coal field. Scale of map 1 : 625,000.

urban community. The entire valley boasts a population of more than 600,000, of whom approximately 160,000 live in Scranton.

Dunmore, although a separate political unit, is considered to be a part of Scranton, for a portion of Dunmore extends almost to the center of Scranton, and the two cities are economically one.

LOCAL SETTING AND STRUCTURE OF THE CITY

In spite of the fact that Scranton formerly consisted of several independent settlements, the city is at present a compact community.

The built-up portion extends for a distance of five miles along the Lackawanna Valley and has an average width of about three miles. The city occupies not only the flood plain of the Lackawanna River but also a series of terraces and several minor ridges which, paralleling the river, rise as high as 400 feet above the lowland. When viewing the area from higher vantage points within the city, one is impressed with the pleasing combination of lesser valleys and minor ridges over which the community spreads; but always the higher, tree-covered, mountain ridges (1400 feet above the valley floor), which border the major valley, stand out as the dominating topographic features. Only Nay Aug Gap on the east and Leggetts Gap on the west, like great notches cut into the mountain walls, break the general levelness and continuity of the crests of the bordering ridges. Those well located gaps and a number of fortunately situated antecedent stream valleys afford satisfactory railroad routes across the highland both to the east and to the west of Scranton, and they have had a profound effect upon the establishment and growth of the city.

The expansion of the city has been most pronounced and easiest along the axis of the valley. It is in places difficult to determine just where the boundary lines occur between Scranton and Taylor borough and Lackawanna township on the south, and of Dickson City and Throop on the north. It is not improbable that those four communities, as well as Dunmore, may in the future become parts of political Scranton. In places the city has spread up the lower slopes of the bordering mountain ridges in spite of their restrictive effect upon city expansion. The effect of the ridges upon the plan of the city, its direction of growth, and its compactness is clearly evident (see Fig. 5, p. 422).

The absence of cultivated farm land and market gardens near the city is one of the noteworthy features of the Scranton area. The none-too-fertile soil and the intensity of mining operations cause the Lackawanna Valley to be practically devoid of all types of agricultural activity. Even the small home vegetable garden, so typical in many communities of similar size elsewhere, is seldom to be seen in Scranton.

In most parts of the city the principal streets or avenues extend along the axis of the valley, which is in the direction of the greatest traffic movement. In most parts the longer sides of the blocks extend north and south, which further facilitates the movement of the heaviest traffic. Steep grades occur on many of the cross streets as they ascend to the tops of the minor ridges or rise along the lower slopes of the major valley sides. The Lackawanna River for the entire length of the city interferes with east-west travel. However, a dozen or more bridges enable one to cross the stream along the more important cross streets.

Among the unique features of the urban pattern of Scranton are the large areas of land within the city and along its immediate borders that are occupied by collieries. The breakers themselves with their huge piles of culm, railroad yards, and many associated mine buildings constitute the most striking features of the cultural landscape. Most of the vacant land within the city or immediately surrounding it is likewise owned by coal companies. Nor is that land likely to be released for building purposes until all the underlying coal that can be mined economically has been removed. Most of the city is underlain by several seams of coal, and within each coal bed scores of miles of intricate passageways and innumerable "rooms" have been excavated until each bed resembles a subterranean city.

Scranton as an Industrial Center

Mining has long been Scranton's most important industry, and it has served as the base for most of the city's varied industrial structure. About 15,000 men are employed in the mining industry, and they produce annually about 6,000,000 gross tons of coal.[3] Approximately one-tenth of all the anthracite produced in the United States has been mined in Scranton. A number of environmental conditions made practical the development of this large-scale industry. The coal basin has a greater width and the seams a greater thickness at Scranton than anywhere to the north or immediately to the south.[4] Furthermore, the coal basin at Scranton is in the form of a broad and shallow trough, and the coal beds have not been subjected to serious folding or faulting. Those conditions have made it possible to recover large amounts of high-quality coal with relatively simple and inexpensive mining methods.

At Wilkes-Barre the coal basin again widens and deepens notably, which in part accounts for the development there of the second largest city in the anthracite region. The mining of coal in that portion of the basin is made somewhat difficult, however, because of the greater depth of many beds, the thicker covering of water-logged alluvial material, and the greater structural complexity of the basin.

The principal industrial districts of Scranton occupy the lower portions of the city, especially the lowlands along the five-mile stretch of the Lackawanna River. They also extend into the minor valleys of Keyser Creek, Roaring Brook, Leggetts Creek, and Stafford Meadow Brook. Railroads could be constructed in the valleys with least difficulty. Chiefly because of the large areas of suitable land available there, and in order to secure direct railroad connections, all of the

[3] State Bureau of Statistics and Information, Harrisburg; and Pennsylvania Department of Mines.

[4] James Macfarlane: The Coal-Regions of America: Their Topography, Geology, and Development, New York, 1873, p. 49.

FIG. 2

FIG. 3

FIG. 4

FIG. 2—Scranton from the mountain ridge at Leggetts Gap looking to the south. The Lackawanna Railroad is shown as it leaves the gap. Across the valley is the ridge of the Moosic Mountains.

FIG. 3—A view to the west from the central business district of Scranton. Note how the city spreads over the low Hyde Park Ridge: Keyser Valley lies beyond, and the tree-covered ridge of the Bald Mountains forms the sky line.

FIG. 4—The south end of Scranton. The Lackawanna Railroad is on the right. Note the spread of the city up the gentle slope of the east mountain ridge, Moosic Mountains. Keyser Creek, choked with mine waste, in the foreground.

collieries and also most of the industrial establishments were located in the lowlands.

The large production of anthracite at Scranton and the strategic position of the city with reference to railroad outlets from the Lackawanna Valley were the primary factors leading to the concentration of railroads at that place. The main line of the Lackawanna Railroad, connecting Hoboken and Buffalo, utilizes both Nay Aug and Leggetts Gaps in crossing the Lackawanna Valley. The Erie Railroad also enters the valley through Nay Aug Gap. Several other railroads approach the city along the axis of the valley. Scranton, because of its importance as a coal-assembling and shipping center and as a freight and passenger division point, was the logical place at which to locate railroad-car and locomotive repair shops. The principal repair shops of the Lackawanna Railroad and the smaller shops of three other railroads are located here. More than 5000 persons are employed in the railroad industries at Scranton.

Scranton is unique industrially not only in that it possesses the combined characteristics of a large coal-mining community and of an important railroad center but also in that it is a significant manufacturing city. About 15,000 persons are employed in its factories. Metal-fabricating plants and textile mills are the two principal types of manufacturing industries. The metal-fabricating plants developed in the city in response to a large demand for machine-shop and foundry products among the local mines and railroads. The textile mills were attracted to Scranton chiefly because many girls and women from among the industrial population were willing to work in the mills for comparatively low wages. Among the textile industries the manufacture of silk is of major importance. A number of the textile mills are situated in residential districts occupied by large numbers of industrial workers. Most of them, however, are situated in the low-lying manufacturing districts of the city. The relative nearness of Scranton to the great centers of silk manufacture on the eastern seaboard also appears to have encouraged the spread of the industry to the coal field.

The central business district is situated on a broad, flat terrace just north of the mouth of Roaring Brook. Several small business districts in other portions of the city were established before the time when those sections were annexed to Scranton. Dunmore's small business center is easily recognized on the map.

The less attractive residential districts occur in the lower portions of the city, and usually they are closely associated with industrial districts. On the other hand, the more attractive home sites are on the minor ridges, where there are relative seclusion from industrial and commercial areas, an abundance of pure air, better drainage, and more pleasing views. Many attractive residences are being

built also on the wooded east mountain slope outside the limits of the coal measures.

Along the outer fringes of the city are several small neighborhoods resembling in many respects the typical "mining patches" that have developed around isolated anthracite collieries. They are sharply in contrast with the more developed parts of the city. Most of the residents of each "patch" are employed in the accompanying colliery. In those neighborhoods foreign families predominate, English is seldom heard, unsanitary living conditions prevail, houses are painfully primitive, streets are unpaved, sidewalks are lacking, flocks of ducks and geese and even goats and occasional cows run at liberty through the streets and in the adjoining vacant lots. The huge piles of culm, the sagging and undermined surfaces, the noise of the breakers, the spreading railroad yards, the streams of blackened breaker wash water—all scars of the anthracite industry—combine to destroy the comeliness of the physical environment and to kill the pride of the community.

With the exception of the outlying mining patches, no parts of Scranton are inhabited exclusively by mine workers. Most of the mining population is rather evenly distributed throughout the moderately attractive residential sections of the city, where they are intimately associated with other industrial workers. This distribution of mine workers is related to the fact that the collieries themselves are widely scattered in Scranton. As a result there are fewer predominately mining neighborhoods than there are in many cities of the anthracite region.

Qualities of the City and Its People

Scranton as a city possesses an urban quality that distinguishes it clearly from all other communities in the anthracite region. This may be attributed chiefly to the diversified economic interests of the community, to its large size and compact structure, to its population mixture, and to the ease of communication it enjoys with other urban centers within and without the coal basin.

Quite in contrast with many coal-mining centers, Scranton is a stable and well-rounded community. This also is related to the varied economic interests of the city and to the fact that its principal industry has been carried on steadily for many years because of the large size and the high quality of the local coal deposit. Some 250,000 people live within the metropolitan area of Scranton—ten-mile radius of the city—which fact further suggests the importance of Scranton as a commercial center.

About 20 per cent of the population is foreign-born. The principal sources of this group are Russia, Italy, Ireland, Poland, Austria, Wales, Germany, and England, named approximately in the order

of their importance. More than 40 per cent of the population consists of native-born individuals, one or both of whose parents were foreign-born. Most of those citizens originated from northwestern and central European stock. Nearly 40 per cent of the population consists of native white stock of native parentage. As a whole, Scranton presents the racial aspects that are typical of many American industrial communities. In many of the smaller cities of the anthracite region the foreign elements, especially from southern and eastern Europe, are much more numerous. Usually the smaller the mining community, the larger the proportion of foreigners.

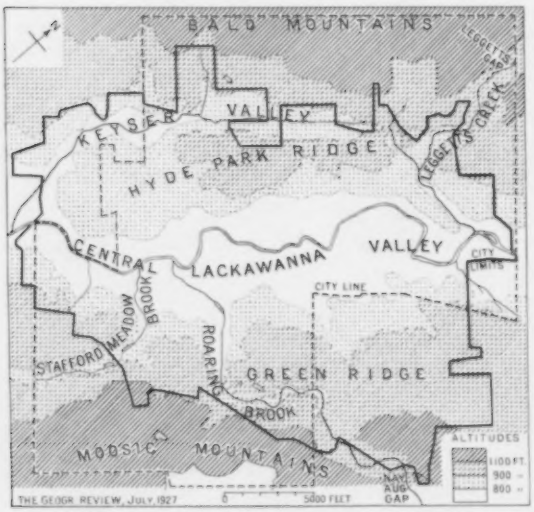

FIG. 5—Topography of the city. Compare Pl. III.

The large demand for laborers of a type already experienced in mining or of a type willing to engage in mining operations has had its influence in attracting certain groups of people to Scranton. The importance of the Welsh population in the city illustrates the acquisition of experienced anthracite miners, while most of the Italian and Polish workers seem to be examples of the other type.

ORIGIN AND GROWTH OF SCRANTON IN RELATION TO ENVIRONMENTAL CONDITIONS

Having interpreted briefly the salient cultural features of the present city, the origin and growth of the community will next be discussed in order to discover, if possible, additional facts that will aid in explaining the qualities of the present city, and the environmental factors which have affected its development.

The area about Scranton was first settled in 1769.[5] Among the first lands to be appropriated were the low, rich bottoms (Capouse Meadow) along the Lackawanna River and within the present limits of Scranton, which apparently had been cultivated even earlier by the Indians. The first colonists came chiefly from Connecticut, entering

[5] The chief sources are Horace Hollister: Contributions to the History of the Lackawanna Valley. New York, 1857; *idem:* History of the Lackawanna Valley, 5th edit., 1875; and F. L. Hitchcock: History of Scranton and Its People, 2 vols., New York, 1914.

The Geographical Review, Vol. XVII, No. 3, 1927, Plate III

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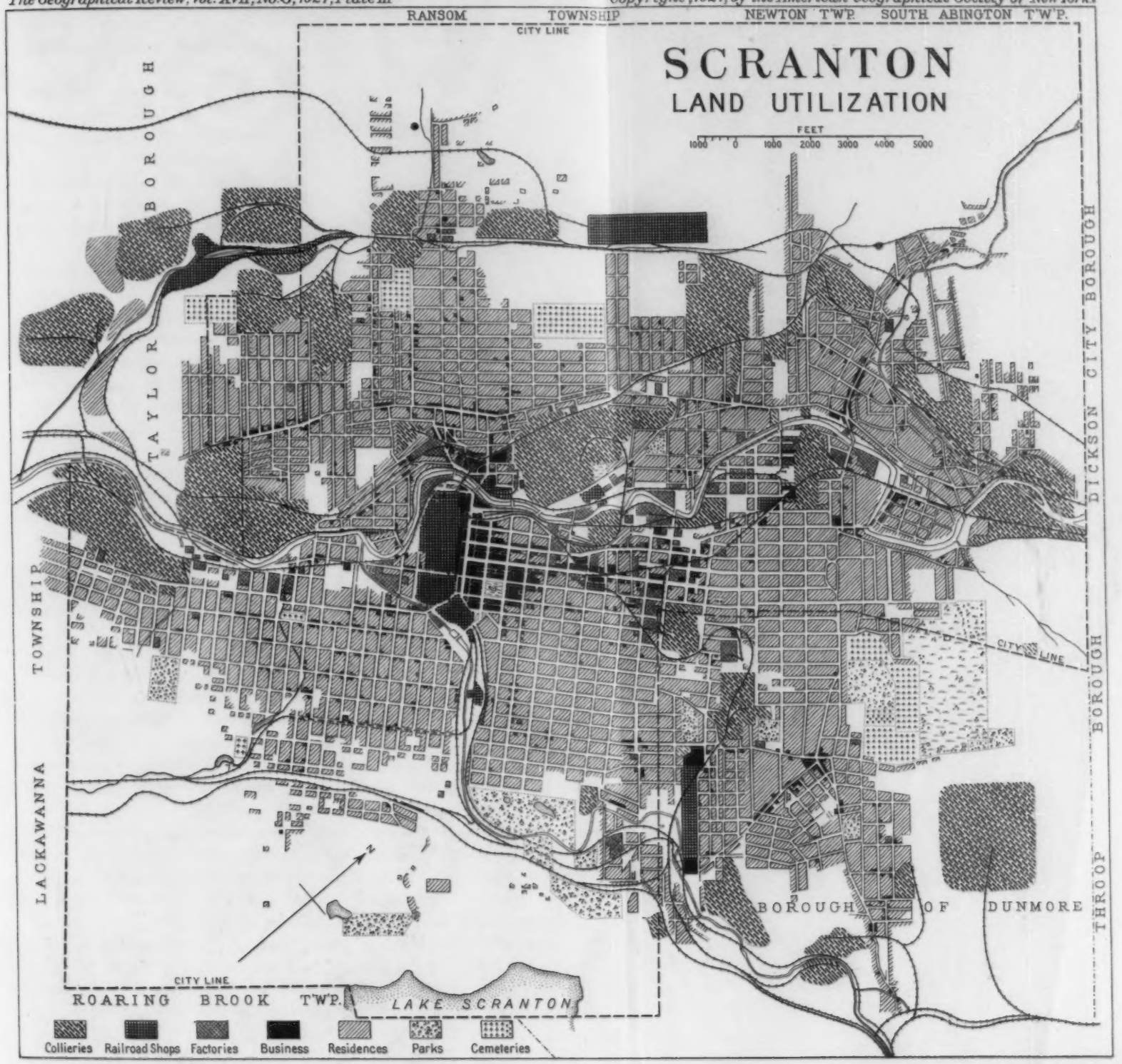

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the Lackawanna Valley along an old Indian trail extending from the Delaware River through Nay Aug Gap to the site of Scranton. By 1788 the number of settlers in the vicinity and the increased production of grain warranted the erection of a gristmill, Scranton's first industrial establishment, on an excellent site offered by the lower course of Roaring Brook. Farmers living 20 miles away sought the mill with their grain. In 1799 the gristmill was improved and enlarged, and a distillery—to use the surplus grain produced in the vicinity—a sawmill, a cooper shop, and a blacksmith shop were erected. A number of houses, together with the group of small industries along the brook, constituted in 1800 the thriving little village of Scranton.

In that year the first important attempt was made to utilize the mineral resources of the area. A small furnace and a forge were constructed to manufacture plowshares and other farm implements from iron ore exposed along the banks of several creeks in the vicinity. Although coal beds outcropped along the creek banks beside the furnace, charcoal alone was used for fuel.

The expense of manufacturing was so great that only an insistent demand for the products over a wide area made possible the continued operation of the furnace. In 1826 it was abandoned largely on account of difficulties of transportation, attempts to amend which proved abortive for some time. Somewhat later the distillery also was closed, and the village sank into a period of decadence. Hopes of reëstablishing the industry, however, were not lost, and in 1839 the area between Pittston and Scranton was carefully examined for selection of the most practicable location for an ironworks. "On the low, wild, narrow strip of land, lying almost in the forks of the Lackawanna and the Roaring Brook," iron ore was found, "the analysis of which proved so productive and inviting as to determine at once the site of the furnace."[6] Anthracite was to be used for fuel in the new furnace instead of charcoal. High-grade coal outcropped in a ten-foot vein on both sides of the creek and within a few rods of the furnace. The adjacent ore deposit proved to be too expensive to work, but fortunately "a rich body of iron ore" was discovered on the slope of the Moosic Mountains, about three and a half miles from the furnace. For several years after its completion in 1841, the operations of the furnace were successful metallurgically, although the quantity of iron made was less than had been expected.

At that time the principal market for the product of the furnace was on the eastern seaboard. In order to reach that market the company had the choice of two routes, both of which were hard, slow, and expensive: the one along the Delaware and Hudson Canal to Rondout on the Hudson, the other along the North Branch Canal,

[6]Hollister, Contributions, etc., pp. 106–107.

FIG. 6

FIG. 7

FIG. 8

FIG. 6—Nay Aug Gap cut by Roaring Brook in the ridge of the Moosic Mountains to the east of Scranton. The Lackawanna Railroad on the left, the Erie Railroad on the right.

FIG. 7—Leggetts Gap through the ridge of the Bald Mountains to the west of Scranton. The Lackawanna Railroad on the farther side of the gap. In the center the Lackawanna Trail and the Northern Electric Railroad, both of which extend to Binghamton, N. Y.

FIG. 8—The mixed farming and dairying region which lies to the northwest of Scranton as seen from the top of the forested ridge of the Bald Mountains near Leggetts Gap.

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FIG. 9

FIG. 10

FIG. 11

FIG. 9—A breaker near the central part of the city. Many acres of valuable city land are covered with heaps of blackened mine waste and fine coal.

FIG. 10—A large modern breaker in the Dunmore section. The surrounding land is fractured and caved as a result of mining operations. Caving is a serious municipal and industrial problem.

FIG. 11—A small "mining patch" on the south side of Scranton. Note the silt-laden stream of breaker wash water, the huge piles of mine waste, the silt-covered areas along the stream, and the crowded, unattractive settlement.

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which extended along the Susquehanna River to Havre de Grace, Maryland. In both cases the iron had first to be hauled considerable distances by wagon. To the North Branch Canal at Pittston the distance was seven miles. To Carbondale, the terminus of the gravity railroad extending over the mountains to the western end of the Delaware and Hudson Canal at Honesdale, it was 15 miles.

The enterprise thus far had been a losing one, and when it became apparent that to continue selling pig iron alone would always be unprofitable a rolling mill and nail factory were added. This marked the turning point. In 1846 an order for 12,000 tons of iron rails was secured from the Erie Railroad—an order of great significance to the Scranton company.

Scranton at that time began its rapid development. Two large blast furnaces were erected. A well-graded railroad, using mules for drawing the cars, was constructed to the ore deposit. On the south side of Roaring Brook some 300 houses for the workmen were built. As the production of the blast furnaces was not equal to the needs and capacity of the rail mill, pig iron in large quantities was purchased in Columbia County and brought by canal to Pittston and then by wagon to Scranton. Limestone also was brought from near Danville along the same route.

The rapid expansion and concentration of business at Scranton soon emphasized the necessity of having some satisfactory connections with the Atlantic seaboard and also with the Great Lakes. The owners of the ironworks frequently discussed the importance of a railroad leading to the market as a necessary adjunct to their business. In fact it was the most confident expectation of a railroad being extended both to the east and west at no distant date that went far toward the selection of Scranton as the site for their industry. The charter of a partially surveyed railroad extending northwest from Scranton through Leggetts Gap and joining the Erie Railroad at Great Bend was purchased, and the road, 48 miles in length, was completed in 1851. To carry out the original plan of connection with New York City, a survey was made in 1851–1852 for the railroad to the east through Nay Aug Gap. Early in 1856 it was completed to the Delaware River where it joined the Central Railroad of New Jersey, the two forming the first all-rail connection between the anthracite fields and New York City. At that time the two roads extending to the east and to the west of Scranton were consolidated under the name of the Delaware, Lackawanna, and Western Railroad. Thus after a struggle extending over several decades, Scranton finally was made accessible by railroad to both eastern and western markets, a triumph largely due to the city's position between two favorably situated gaps in the bordering mountain ridges. The two greatest factors in the fortunes of Scranton at that time were the Lackawanna

Iron and Coal Company and the Delaware, Lackawanna, and Western Railroad. So greatly were the interests of the town, both individual and corporate, identified with those two corporations that everything revolved about them. The two corporations owned most of the land within the city, and the prices of land fixed by the Lackawanna Iron and Coal Company were a standard.

After the completion of the east and west railroads the production and shipping of coal, which proved to be the underlying basis for most of Scranton's later growth, was begun. For some time, however, much difficulty was experienced in marketing large quantities of the product at a profit, for most coal consumers were unaccustomed to anthracite.[7] The owners of the ironworks, nevertheless, opened several collieries to tap the rich reserves of coal, and for years they were the principal shippers of anthracite from Scranton.

The extension of the lines of the original Lackawanna Railroad and the invasion of the city by new railroads in order to acquire a share of the profitable coal traffic further aided the development of Scranton. The Lackawanna acquired branch roads extending through the coal field both to the north and to the south, and thus it early became one of the principal anthracite-carrying railroads. When the coal properties of the Delaware and Hudson Company in Scranton were developed in 1860, their railroad was extended to the city. A branch of the Erie Railroad was constructed by way of Nay Aug Gap and the Valley of Lackawaxen Creek to serve the collieries of the Pennsylvania Coal Company at Dunmore and elsewhere. In 1886 and in 1890 branches of the Central of New Jersey and the New York, Ontario, and Western railroads, respectively, were extended to Scranton to tap that portion of the coal field. Thus it is seen that as large, new companies acquired collieries in the Scranton district each planned a new transportation line because of the close relationship existing between coal mining and transportation interests. With the invasion of the city by numerous railroads, Scranton's importance as a coal-shipping center increased, and the city also benefited through the establishment there of repair shops and other railroad industries.

Along with the expansion of the coal-mining and railroad industries, there developed in Scranton a group of metal-fabricating industries whose products were in demand among the railroads and the collieries. The textile industries began to appear shortly before 1880 and rapidly increased in importance. Both of these groups of industries have had an important part in the growth of the city.

The annexation of Hyde Park and Providence boroughs to Scranton in 1866 is another fact that helps to account for the growth of the city. At that time Hyde Park was a thriving little community, and since it contained several producing collieries its annexation was of

[7] Hitchcock, *op. cit.*, p. 62.

immediate importance. Only the river separated it from the Scranton of early days. Providence was a small village separated from the other boroughs by a mile and a half of vacant land and lying along the most direct route of travel between Leggetts Gap and the main highways of the Lackawanna Valley.

Dunmore was an isolated village at the foot of one of the gravity planes operated over the Moosic Mountains by the Pennsylvania Coal Company for transporting coal from the Lackawanna Valley to the Delaware and Hudson Canal at Hawley. Later coal mining was begun in Dunmore, and from that time the collieries of the Pennsylvania Coal Company have been the principal cause for the growth of the place. The formation of the new county of Lackawanna from the northern portion of Luzerne County, in 1878, and the selection of Scranton as the county seat undoubtedly contributed to the growth of the city.

In 1901 Scranton lost an industry which for 60 years had been of great significance in the development of the city. In that year the iron and steel furnaces and rolling mills of the Lackawanna Iron and Coal Company were abandoned and the plant was reëstablished at Buffalo. Furnaces at Buffalo were far better situated for utilizing Lake Superior ore, good coking coal could be secured cheaply, and Buffalo was no less favorably situated than Scranton with regard to important markets for iron and steel products. When coke was widely substituted for anthracite for fuel in blast furnaces (about 1875), Scranton lost one of the principal attractions it originally had to offer the industry. The low-grade iron ore deposits at Scranton were entirely inadequate to supply the needs of the industry as soon as it attained a large size. Most of the ore used by the furnaces at Scranton in later years was secured from Danville and Bloomsburg, Pennsylvania, at considerable cost.

In spite of that enormous industrial loss at the opening of the twentieth century Scranton surmounted the difficulty, as is shown by its continuous growth in population. Expansions of the coal and railroad industries were the principal factors that prevented an appreciable slump in the development of the city at that time. The larger non-mining industries of present-day Scranton have become so firmly established that they probably will continue to prosper long after mining has ceased to be significant. Furthermore, because of Scranton's regional position and its excellent transportation facilities, other industries may be introduced which will further help to insure the future of the community.

A PICTURE OF THE DISTRIBUTION OF POPULATION IN PENNSYLVANIA

Clarence E. Batschelet

U. S. Bureau of the Census

THE accompanying map, Figure 1, portrays the distribution of population in Pennsylvania by the "dot" method.[1] Irregular symbols are used for the larger cities, those having 50,000 population or more.[2] The census of 1920 returned 13 places with such a population, the largest, Philadelphia, having 1,823,779 inhabitants. The cities and boroughs having a population of under 50,000 were divided into three groups, and the area of the circles was apportioned to the total population as represented by these groups: places of from 25,000 to 50,000 population, of which there were 7; 10,000 to 25,000 population, of which there were 57; and 2500 to 10,000 population, of which there were 237. For the remaining population of the state, i. e. the population of incorporated places under 2500 and the unincorporated segregated population, as well as the rural population, a unit of 200 population was used, with the size of the dot in proportion to the circles used for the larger cities.

Size and Location of Dots

The question as to the size of the dot and the number of persons represented was perhaps the most difficult problem presented by the map, and it was only after considerable experimental work, in which dots representing from 50 to 500 persons were plotted in the most sparsely as well as the most densely settled townships, that it was decided to use a dot to represent 200 persons. A dot representing less than 200 covered the space and made too dense a mass, thereby destroying the detail; and if the unit represented more it necessitated too great centralization of the dots for the scattered population, thereby distorting the picture.

In locating the population the dots were placed geographically for the incorporated boroughs and cities. For the unincorporated places and the rural population the United States Geological Survey topographic sheets were used. Sheets were available for approximately two-thirds of the state, or 30,000 square miles out of a total of 44,832.

[1] Compare Wesley Coulter: A Dot Map of the Distribution of Population in Japan, *Geogr. Rev.*, Vol. 16, 1926, pp. 283–284.

[2] Data from Fourteenth Census, Vol. 1: Population—Number and Distribution of Inhabitants and unpublished statistics for Census Enumeration Districts.

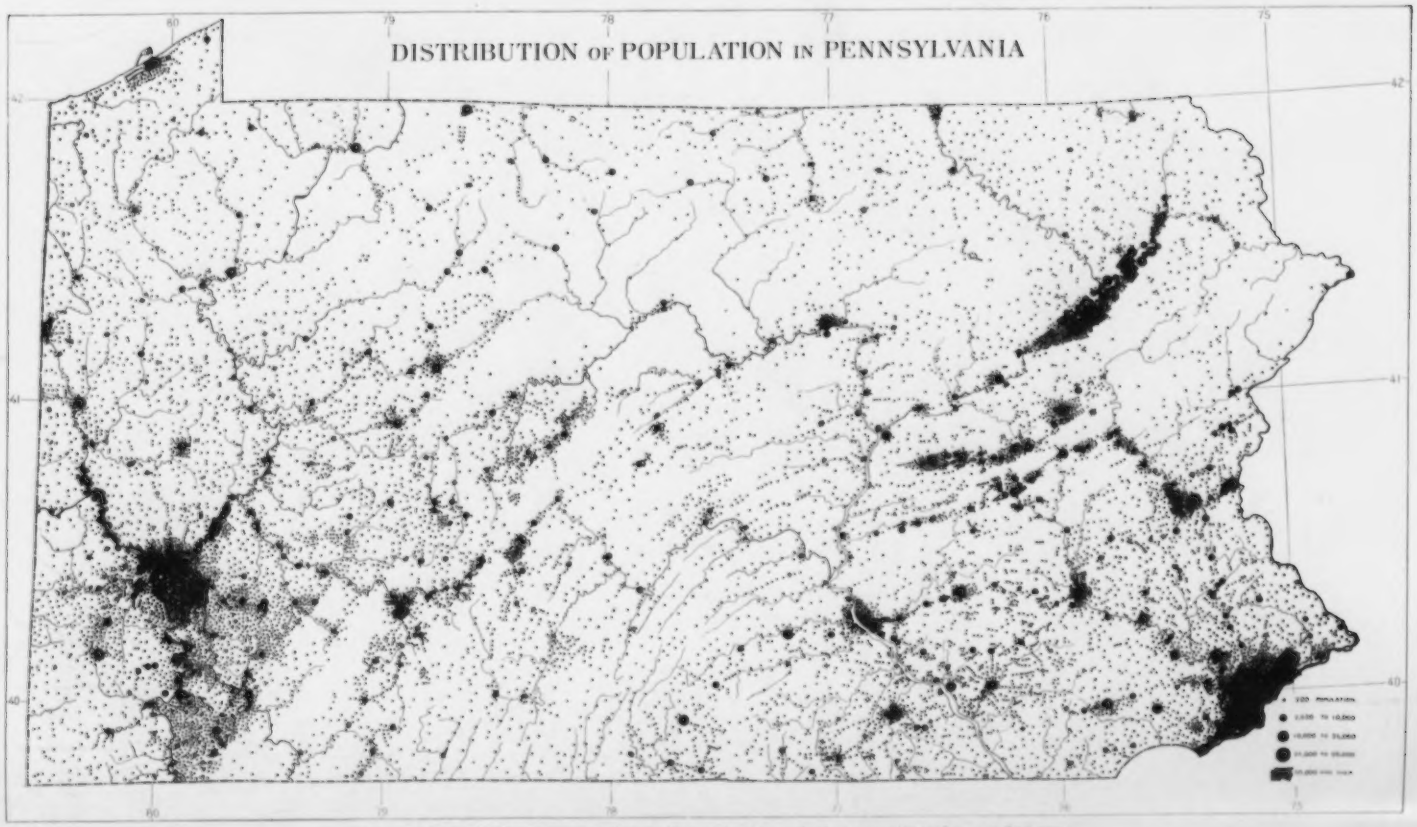

FIG. 1—Distribution of population in Pennsylvania. Scale approximately 1 : 2,800,000.

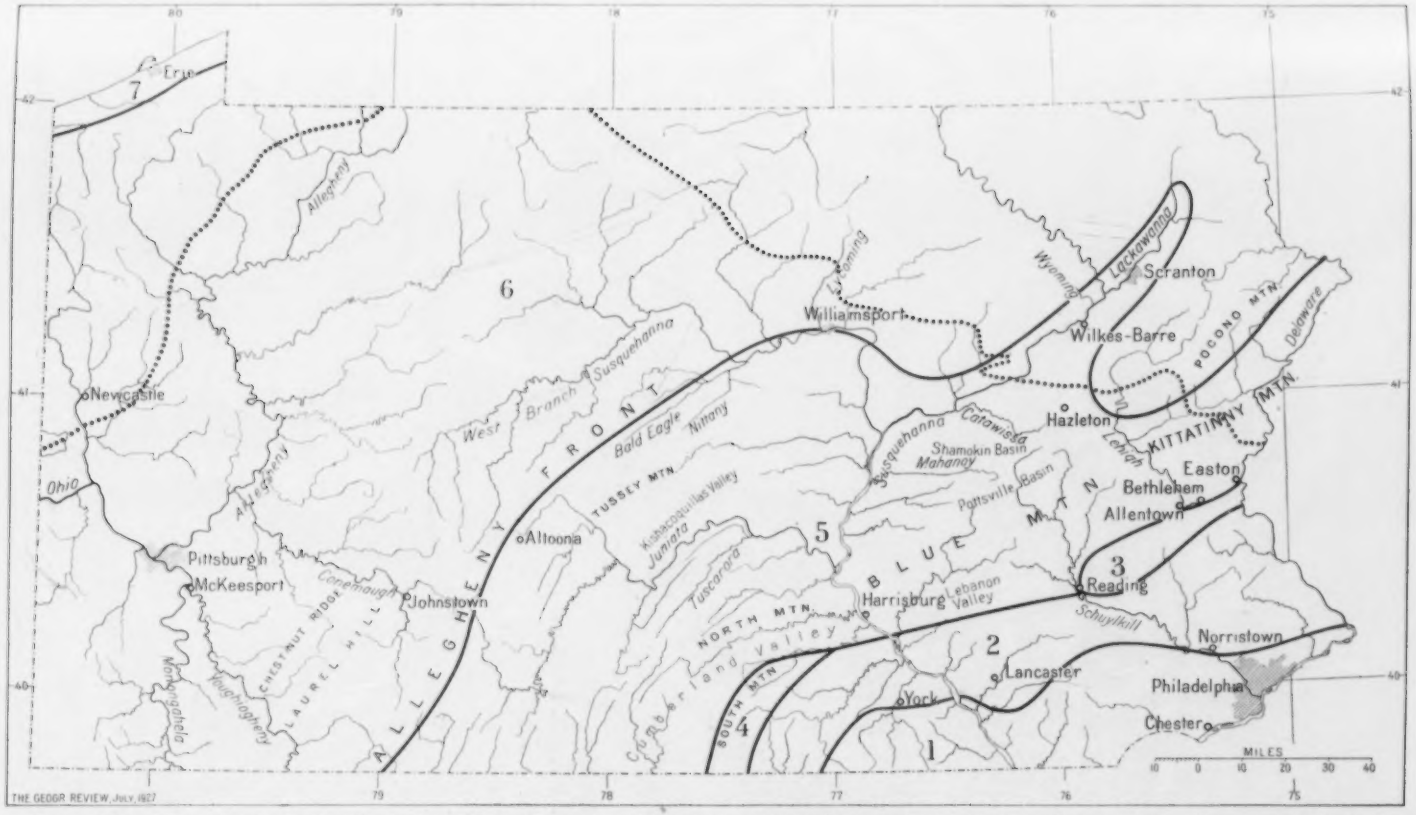

FIG. 2—Map of Pennsylvania showing the physiographic provinces, the cities of over 25,000 population, and some important feature names. The numbers refer to the physiographic provinces: 1, Piedmont Upland; 2, Piedmont Triassic Lowland; 3, Blue Ridge; 4, New England Upland; 5, Appalachian Valley; 6, Appalachian Plateau; 7, Central Lowland of the Interior Plains. The glaciated regions of the northeast and northwest are delimited by a dotted line.

Had the state been completely surveyed the entire study could have been greatly facilitated. For the territory not surveyed in detail, the State Highway map, scale six miles to the inch, issued by the State Highway Commission, showing roads and towns as well as county and township boundaries; the Electric and Steam Railroad map, scale six miles to the inch, issued by the Public Service Commission; and other standard maps were used.

A county map showing township lines, with the dots as finally plotted thereon, was sent to each county agricultural agent with the request that he examine critically the location of the dots as representing the actual distribution of the rural population. The replies received from these agents were gratifying in that for most of the counties the distribution was stated to be satisfactory.[3] Verification was particularly desirable where topographic sheets were not available and for some sections of the state where the population had changed materially since the survey had been made.

Relation to Topography

The population density is closely related to the relief. It is noticeable how thickly the population is located in the rich farming valleys and how in the central part of the state, the Appalachian Valley, these parallel the mountain ridges. This is in striking contrast to the scattered population in the northern central part of the state. One can easily follow the direction and location of the Chester, Lancaster, Lebanon, Cumberland and York, Schuylkill, Lehigh, Nittany, and Kishacoquillas Valleys, for instance. The population map, Figure 1, should be compared with Figure 2 showing the boundaries of the physiographic provinces[4] and for detail should be compared with the geological map or the soil maps of the state.[5]

The districts immediately surrounding Philadelphia, Pittsburgh, and Scranton are densely populated. The Middle and Southern Anthracite Basins, with Hazleton, Shamokin, and Pottsville as their chief centers, also stand out distinctly. Another interesting feature is the alignment of the population along roads and electric lines radiating from cities, such as York, Lancaster, Harrisburg, and Johnstown.

In contrast we note the lack of people living on the Pocono, South, Blue, North, Tuscarora, and Tussey Mountains, the Chestnut Ridge, and the Alleghany Front. The direction of the mountain folding is clearly depicted by the population distribution.

[3] For 18 of the 67 counties minor changes were suggested; for 7 counties no replies were received; and for 2 counties there were no letters sent, as the counties had no county agents.

[4] Compare A. K. Lobeck: The Physiographic Influence Upon the Distribution of Population in Maryland and Pennsylvania, *Annals Assn. Amer. Geogrs.*, Vol. 16, 1926, pp. 94–101.

[5] Reconnaissance Survey Soil Map of Pennsylvania: Southwestern sheet, 1909; northwestern sheet, 1909; south-central sheet, 1910; northeastern sheet, 1911; southeastern sheet, 1912. U. S. Bureau of Soils.

In the Piedmont Upland area the density is nearly 1200 per square mile, compared to a density in the glaciated area of the Appalachian Plateau of about 50 per square mile. This latter area is rough and has little good tillable land except between the ridges and on their lower slopes. There is, however, an appreciable difference in pattern of population distribution between the glaciated region and the contiguous part of the Appalachian Plateau, the former showing more even distribution, the latter being notably confined to the valleys. This unglaciated plateau country beyond the northern end of the bituminous coal field is the most scantily populated part of the state. Topography is very rough: a considerable area is properly preserved in state forests.[6]

[6] See State Forest Map of Pennsylvania on the scale of six miles to an inch, Dept. of Forestry, 1922.

SOME ECONOMIC PROBLEMS IN THE BALTIC REPUBLICS

A REVIEW OF RECENT LITERATURE

Eugene Van Cleef

Ohio State University

ONE of the important consequences of the Great War was the sloughing off from Russia's western periphery of four new republics: Finland, Estonia, Latvia, and Lithuania. As separate political entities they found themselves confronted with serious problems: only Finland, which had possessed a qualified domestic autonomy, had experience to build on. To quote from a recent survey: "It is impossible to compare pre-war and post-war Latvia from an economic point of view, as before the war Latvia was nothing more than a factor in the Russian industrial system, pursuing entirely different aims from her present-day objects."[1] That these patient groups of the north have succeeded well in spite of their disabilities is revealed in the rather meager literature describing their recent activities.

In all four states the agrarian problem repeatedly comes to the fore. The industrial phases of the struggle receive nearly as much attention, since a goodly portion of the political development not only has brought the agrarian and industrial views into sharp contrast but oftentimes almost to the point of destructive conflict. The clash of ideas has arisen largely out of the paucity in variety of natural resources, the preponderance of those whose greatest value is attained through industrial manipulation, and the geographic conditions peculiar to the respective countries. Although the problems confronting each of the new republics are fundamentally similar, their variations are sufficiently diverse to warrant consideration by individual countries.

Finland

A region lacking the possibility of producing sufficient food for itself can hope for progress only if it possesses a surplus of some readily marketable resource. For Finland the forest plays a saving rôle.

"The greatest economic wealth of the country is contained in the forests of Finland," says Numelin[2] in a discussion of the economic

[1] *Econ. Rev.*, Vol. 14, London, 1926, Aug. 13. p. 148. This is equally true of Estonia and Lithuania. In addition it must be recalled that these regions were thoroughly disorganized as a result of the war.

[2] Ragnar Numelin: Some Aspects of the Geography of Finland. Government Printing Office. Helsingfors, 1923.

FIG. 1—Map of the Baltic States of Finland, Estonia, Latvia, and Lithuania. Scale 1 : 13,000,000.

activities of Finland in one of his recent brochures. The widespread distribution of the thousands of lakes combined with their navigability as well as their proximity to one another has contributed to the spreading of the population over the country and has facilitated commerce. But more important than the waterways are the forests, which represent the primary economic wealth of the country. Ilvessalo[3]

[3] Yrjo Ilvessalo: The Forest Resources of Finland. Helsingfors, 1924. Reprinted from Communicationes Ex Instituto Quaestionum Forestalium Finlandiae Editae 9.

points out that over 73 per cent of Finland's area is in forest, while over 58 per cent is productive forest land. Of the forested area 55 per cent consists of pine (*Pinus silvestris*), with spruce (*Picea excelsa*) and birch (*Betula odorata and Betula verrucosa*) constituting most of the remainder. These types are well adapted for timber production. Although over half is privately owned, regulation of cutting and planting has been so effective that at present "the amount of the annual increment is 44.40 million cubic meters while consumption is estimated at 40 million cubic meters."

The timber industry and its influence upon the whole economic structure of the country are clearly presented by Kovero,[4] Director of the Central Statistical Bureau, through the medium of numerous tables and their lucid interpretation. "The wood trade," says Kovero, "may be considered as the most important branch of Finnish industry." Its significance lies not only in its money value but in the full-time employment which it offers the people, "about one-third of all the factory workers in the country [being] employed in the wood industry," and in the part-time employment afforded farmers whose crop income during the long winter season is negligible and for whom life on the farm would be impossible if, in many instances, it were not for the supplementary income provided by the industry.

The Agrarian Problem

The timber resources have a close relation to industrial development. Agricultural interests are to some extent opposed. The two elements have given birth to two strong political parties. The agrarian element has grown in strength rapidly. At the end of the first six years of the republic, Dr. Relander, of the Peasants' League, was elected to the presidency, and 22 per cent of the parliamentary representation belongs to that party.[5]

The official statement "Land Reform in Finland, 1922" gives a summary of the earlier stages of the movement.[6] From the beginning of the century endeavors had been made to provide land for the landless but with no great success while the country remained dependent. After 1917 reform began in earnest and, thanks to the legislation of 1918, "by the end of 1922, no less than 50,000 small holdings, crofters and rural dwelling sites, have been reconstituted as independent freehold properties." In 1922 a law "for the provision of land for the purpose of colonization" went into effect. Reviewing this law the

[4] Martti Kovero: The Timber Industry of Finland. Government Printing Office, Helsingfors, 1924.

[5] For a summary of political parties and the relative position of the agrarian element in this and the other Baltic States see the Council on Foreign Relations' publication edited by Malcolm W. Davis, "A Political Handbook of Europe," New York, 1927.

[6] Land Reform in Finland, 1922: Official Statement. Government Printing Office, Helsingfors, 1923.

official statement points out that the steps taken differ vastly from those adopted in the Baltic States, Poland, and Czechoslovakia in that compulsory purchase in Finland is the last resource. The land reform movement has gone on apace, with the national government extending liberal loans to those desiring to own the land they have been farming. The enthusiasm of the farmers for their new liberties, involving the actual ownership of the land they worked and the production of a small amount of exportable butter, has perhaps caused them to lose sight of the significance of the nation's surplus timber as the only consequential surplus.

FIG. 2—A bit of the virgin forest of Finland, of equal importance to farmer and industrialist.

Finland's soils do not favor the production of a large variety of crops, as Frosterus[7] shows in his classification of soils. Nor are the areas of favorable soils extensive. Only about eight per cent is now under cultivation (fields and meadows). Most of the cultivated soils are the clays of the southern and southwestern district, while the moors of the central regions and the sands of the Viborg Corridor and the north half of the Bothnian coast are left to produce natural meadow. The poorly drained far-northern lands as yet are unproductive.[8] Associated with the poverty of the soils is a climate conducive to the growth of natural grasses and root crops rather than other varieties

[7] Benjamin Frosterus: Die Klassifikation der Böden und Bodenarten Finnlands. *Agrogeol. Meddelanden No. 18*, Geol. Kommissionen i Finland, Helsingfors, 1924.

[8] The distribution of "settled" land comes out strikingly in the map "Norden" (Sweden, Norway, Denmark, and Finland), 1: 1,500,000, edition of 1926, reviewed in this number of the *Review*.

of agricultural products. Frosterus' soil classification should prove an invaluable aid to a scientific development of Finland's agriculture. Although interpreting it in the light of Finnish enthusiasm for soil cultivation, one cannot help feeling that the agricultural future as pictured by the Finns is fraught with serious difficulties.

The record of a typical year (1924), analyzed by the Department of Overseas Trade of England,[9] reveals that over one-third of Finland's imports consisted of foodstuffs and that less than one-sixth of her total exports were agricultural products, while her timber products and their derivatives made up 86 per cent of the total exports. In this same year over one-third of the imports were foodstuffs, paid for largely from the proceeds of forest-products sales. After discussing the crop difficulties the report proceeds to the following conclusion: "The farmer is now . . . beginning to turn his attention to cattle-breeding and Finland, in this respect, appears to be gradually returning to the conditions prevailing before the Great War. . . . The transfer from agriculture to cattle-breeding has been of late so prominent a feature that the Government has been obliged to consider means of improving the cultivation of grain."

A graphic presentation of Finland's agriculture appears in an atlas printed with Finnish, Swedish, and French text, the French title reading "L'Agriculture de la Finlande en Diagrammes et Cartes."[10] This scholarly atlas, including a reproduction of maps and diagrams prepared for the Twelfth Finnish Agricultural Exposition, has received official recognition and assistance. It brings down to 1920, and in some instances to 1922, data that were first presented in the "Atlas de Finlande" of 1910. A detailed review of the 317 maps and diagrams cannot be presented here, but for the student of Finland's agriculture this atlas is indispensable. One is impressed by the country's agricultural progress as well as that of her forestry, for which data are included in the atlas. While forestry is not commonly classified as agriculture, there appears no serious objection to construing it so in the case of Finland, where the forests are under control and are planted and cropped annually. In addition to the graphical representation of crop areas and production, the subject of coöperative societies concerned with production, with export, with farm financing, and virtually every activity in any way directly associated with or growing out of agriculture receives detailed consideration.

Water Power

Although the annual forest increment exceeds consumption by about four millions of cubic meters, any economy which can be

[9] C. H. Mackie: Rept. on the Economic, Financial, and Industrial Conditions of Finland. Department of Overseas Trade, H. M. Stationery Office, London, 1925.

[10] Suomen Maataloutta Kuvioin ja Kartoin. Edited by K. J. Ellilä, E. Cajander, E. Hynninen, O. Heikinheimo, J. Jyske, and Simo Lilja. Werner Soderstrom Osakeyhtio, Porvoo, 1925.

effected in domestic consumption will release that much more for export. The prospect for further saving is revealed in the water-power development both under way and potential. Christiernin reports the potential power in Finland as totaling 2,500,000 horse power.[11] Developments now under way will provide sufficient power not only for the local sawmills and paper mills but for operating the main-line railroads in southern Finland, which in the absence of domestic coal burn considerable quantities of wood as locomotive fuel. This new power will also serve the farms. Christiernin states that "five years ago only twenty communes in Finland were supplied with electric energy, whereas this year [1923–1924] the number partly or wholly electrified amounts to 200, or 40 per cent of the total number."

The Karelian Boundary Question

An international political controversy involving the territory of East Karelia[12] in Russia apparently has found at least a part of its stimulus in Finland's desire to increase her forest resources. When Finland signed the treaty of peace with Soviet Russia at Dorpat, 1920, the question of the autonomy of East Karelia arose.[13] The Soviet[14] régime agreed to East Karelian domestic autonomy, while Finland was desirous of Karelian self-determination in the hope that the Karelians would express the wish to join their brothers in western Karelia already incorporated within Finland. The wish was expressed, but the Soviets ignored it and also refused to permit the League of Nations or any other proposed intermediaries to interfere in the matter. The documents presenting the exchange of notes between Finland and Soviet Russia and the opinions of influential Finnish leaders might lead one to suspect that while the Finns were sincere in their desire to see all Karelians freed from Russia and brought within the political boundaries of Finland, they undoubtedly saw an economic advantage to themselves in the resources of East Karelia.

In a valuable work entitled "Nordeuropa" Gustav Braun[15] discusses the relation between East Karelia and Finland. He sets up his own conception of "Nordeuropa," drawing upon geological and geographical data to justify it. In addition to the Scandinavian Peninsula, Finland, and the Kola Peninsula, he incorporates within the region that territory now included within East Karelia and a trifle

[11] Georg Christiernin: Finland's Water-Power and Electrification. Government Printing Office, Helsingfors, 1924.

[12] "East Carelia and Kola Lapmark," edited by Theodor Homén, published in 1921, gives an excellent account of the geography of the region.

[13] La Question de la Carélie Orientale (Septembre 1924). Government Printing Office, Helsingfors, 1924.

[14] Avis des jurisconsultes étrangers sur la question de la Carélie Orientale (1922–1923). Délégation Carélienne, Helsingfors, 1923.

[15] Gustav Braun: Nordeuropa. (Enzyklopädie der Erdkunde.) Franz Deuticke, Leipzig and Vienna, 1926.

more; and he claims for the entire area essential geographic unity. Braun also considers the Kola Peninsula as pertaining geographically to Finland.

Estonia and Latvia

In the new Baltic States to the south of Finland problems analogous to, but in many respects more difficult than, those of the far northern republic are in process of solution.

The Agrarian Question

In an excellent portrayal of the complexity of the Estonian-Latvian problems, largely agrarian in character, Ifor L. Evans[16] refers to the "agrarian drama" as a "story of bitterness and brutality not unfitted to the cold and somewhat monotonous landscape, the rather barren soil, and the rigorous climate of these uninviting Baltic lowlands." The struggle has been intensified somewhat by the ravages of the Great War, the subsequent Russian Revolution, and the desires of the political theorists to put into effect their utopian ideas. The successful resistance against the onslaughts of all these discouraging incursions inspires confidence for the future development of these countries.

Evans points to the long struggle of the peasantry, going back to the early thirteenth century when "the Church and the Teutonic Order between them . . . became the feudal lords of almost the whole of the country . . . the lack of support from Germany, and the cost of defence, led, from the very beginning, to the exaction of tithe and tribute from the native inhabitants." As a consequence of the Russo-Swedish struggles for territorial ownership and the struggle between Poland and Russia, Sweden acquired Estonia and northern Livonia in the middle of the sixteenth century, while Poland annexed the rest of Livonia. In the process "the land had been laid waste to such an extent that 'between Dorpat, Riga and Pernau neither the bark of dog nor the crowing of cock was to be heard.' " This story of distress has been repeated again and again, down to and including the last internal revolutions in the years 1917 to 1921. While at the time of these last revolutions the peasantry owned between 57 per cent and 64 per cent of the agricultural land, there still remained large numbers of "landless proletariat" who wanted land. The very prosperity of the peasant proprietors made the still existing remnants of the feudal régime increasingly irksome to them. Accompanying this desire for landownership there developed a consciousness which today expresses itself in an almost "rabid" spirit of nationalism.

[16] I. L. Evans: The Agrarian Revolution in the New Baltic States, I: Estonia and Latvia, *Slavonic Rev.*, Vol. 3, 1925, pp. 587–608.

FIG. 3

FIG. 4

FIG. 3—Primitive homemade plow and hay sled still commonly used on the remote farms of western Karelia. Note the glacial boulders in the background.

FIG. 4—The splendid port of Tallinn (Revel) commands the trade of Estonia and a fair portion of that of Soviet Russia. Russia enjoys all the port privileges except the right to utilize the port in any way as a military base.

UNIV. OF MICH.

FIG. 5—Home of a prosperous Latvian farmer. Compare the new-style house in Figure 7. (Photograph by courtesy of Latvian Foreign Press Bureau.)

LAND DISTRIBUTION IN ESTONIA

That the agrarian revolution is not at all new is the argument of G. E. Luiga,[17] who presents an illuminating review of the agricultural situation in Estonia. The old order had been protested for years, but only with the establishment of Estonian independence was it possible to inaugurate agricultural reform laws with respect to landownership in a manner satisfactory to the peasantry. The Constituent Assembly of April 23, 1919, passed a new agrarian law which restricted the sizes of the estates and thereby automatically released much land for distribution among the masses. In the appendix to Luiga's booklet, Warep presents a detailed, thorough, concise statistical statement relative to the distribution of the land before and after the new land law became effective. A total of 2,346,494 hectares—not far short of six million acres—were withdrawn from farmer, private, state, and church ownership and distributed among the landless.

A reaction set in after the distribution. Many of those who believed that title to farm property would automatically enrich them or at least remove them from the border line of starvation, became disillusioned, discovering that *work* was an essential requisite to production. Their disappointment nearly created another revolution, but timely action by intelligent leaders forestalled such a catastrophe. With financial assistance from the government and schooling in modern agricultural methods, the peasants, as well as urban peoples

[17] G. E. Luiga: Die Neue Agrarverfassung in Eesti. With Appendix: A. Warep: Die Neue Landordnung. Dorpat, 1924.

FIG. 6—A less up-to-date farmhouse in Latvia. (Photograph by courtesy of Latvian Foreign Press Bureau.)

who acquired farmsteads, found a way out, and now after five years of experience under the new régime the future seems to offer real hope. Haltenberger,[18] in the chair of geography at the University of Dorpat, describes the country as fundamentally agricultural and as having no prospect of a major development in other directions. He likens the country to Holland, a region of intensive agriculture including dairying, and contends that Estonia may, if it chooses, evolve likewise. Convinced that the future of the country must trend in this direction, he emphasizes the physical aspects[19] a knowledge of which he considers basic for a systematic agricultural program.

THE PROBLEM IN LATVIA

Latvia's problems do not differ materially from those of Estonia. The struggles for landownership in the two countries have paralleled each other, and recent developments in the two regions have attained virtually the same status. Perhaps the best brief account in English of what has taken place in Latvia is given by Owen Rutter in his commendable book on "The New Baltic States."[20] Despite its

[18] Michael Haltenberger: Landeskunde von Eesti, I: Die physische Struktur des Landes. Tartu (Dorpat), 1926. See also his paper "Der wirtschaftsgeographische Charakter der Städte der Republik Eesti," Tartu, 1925.

[19] Other geographical studies have already been produced by the Geographical Institute of the University of Dorpat, and this institution is in touch with a society for the study of the country founded in 1920. In 1925 the Society produced a monograph of over 700 pages on the department of Tartu, reviewed elsewhere in this *Review*. A good summary account of Estonia is given by Jonatan Grufman: Estniska republikens geografi, *Ymer*, Vol. 43, 1923, pp. 452–491.

[20] Owen Rutter: The New Baltic States and Their Future: An Account of Lithuania, Latvia and Estonia. Methuen & Co., Ltd., London, 1925.

FIG. 7—Homes of new settlers upon the redivided estates in Latvia. Note the architectural departure from that of the pre-war type in Figures 5 and 6.

recency some of the experiences related would hardly occur to a traveler in Latvia now, for the country is progressing so rapidly that what may be true today may be quite otherwise tomorrow. However, Rutter's optimism for the future of Latvia is well founded, and anyone reading his account may confidently accept it as a fair cross section of actual conditions. It is equally worth while to those interested in a summary view of the other new Baltic States.

Bihlmans[21] presents a survey of economic developments in Latvia since 1918, accompanied by a thorough-going bibliography of the post-war literature. He relegates the pre-republic writings to the shelf of historical documents of little value, so far as concerns the happenings of revolutionary days. As a reference handbook upon Latvia Bihlmans' volume serves an important function. While the author does not attempt a detailed interpretation of the facts he presents, he is of the opinion that, successfully to develop industrially or agriculturally, Latvia must acquire capital upon favorable terms and the people must be willing to sacrifice their personal desires in favor of the national welfare. He believes a unification of the business interests of Latvia, Estonia, and Lithuania would lend strength to all and would conform to the physical conditions of these three countries, which naturally constitute a unit.

For those who have an interest in the details of Latvia's financial structure and the distribution of her trade among the nations, Siew[22]

[21] Alfred Bihlmans: Die politischen und wirtschaftlichen Grundlagen der Baltischen Republik Lettland. (Bibliothek des Baltischen Ostdienst-Verlages für Wirtschaft und Recht.) Riga, 1926.

[22] B. Siew: Lettlands Volks- und Staatswirtschaft. Jonck & Poliewsky, Riga, 1925.

FIG. 8—Flax harvest in Latvia. Flax is one of the country's most dependable and valuable crops, offering direct returns to farmer and industrialist.

offers a comprehensive report. It has been prepared to meet the numerous inquiries for these data, many of which have heretofore been available only in the Lettish language or in Russian.

INDUSTRIAL PROBLEMS

Both Estonia and Latvia have their industrial problems, which have exerted an important influence upon their agriculture. Their climate is not particularly conducive to a large variety of crops. They possess important timber lands though not nearly so extensive as those of Finland. Mineral resources are quite restricted, although Estonia has oil shale deposits which are proving a valuable asset. In pre-war days these countries produced goods largely for Russian consumption; but with that market gone, at least temporarily, either the industrial life must disappear or it must turn to commodities which other markets may consume and where competition permits.

The European demand for butter fats after the war presented an opportunity to these northern countries; and as a consequence they have shifted their agriculture to dairying and the raising of only enough of grains for local needs, while at the same time the manufacture of butter and some cheese has developed into a new and important industry. "L'industrie laiterie en Lettonie," Riga, 1926, an attractive government pamphlet describing the dairy industry in brief, offers a striking picture of the rise, at a seemingly unprecedented rate, of a new national industry. The reports of the Department of

Overseas Trade on the economic and industrial conditions in Estonia[23] and Latvia[24] respectively, make available statistical data, with some interpretation, revealing the high rank of butter and animal products in the export trade of these countries. They also direct attention to the fact that while both countries in pre-war days constituted primary transit districts for Russia's trade, today much of that trade is lost. In this status the British government has a particular interest inasmuch as it looks forward to the possible return of Russian trade through the ports of Tallinn (Revel) in Estonia, and Riga, Libau, and Windau in Latvia, for which business Germany will offer keen competition. It is of interest to note that a Draft Agreement for a Customs Union between Estonia and Latvia was signed at Riga in January last.

Lithuania

"Lithuania is essentially an agricultural country, over 80 per cent of the population being employed on the land, and its future existence must depend to a very large extent on the successful development of its resources in that respect."[25] This well summarizes the situation, and the statement is confirmed by the close correspondence between harvest and trade balance. Like Latvia, the government is devoting considerable energy to the organization of its agriculture, encouraging the peasantry to engage in dairy farming and the raising of swine, eventually to export "butter, cheese and pork in place of grain."

Dr. Hans Mortensen,[26] in a scholarly geographical study of Lithuania, makes the unqualified assertion, "agriculture is the most important industry of Lithuania. . . Over half of the population of Lithuania consists of farm owners, and 76.8 per cent of the population lives in the rural districts." He points to the fact that farm productivity is low, owing both to the short growing season and poor natural drainage, the latter remaining as yet untouched by any effort to improve it mechanically. Aside from limited forest products Lithuanian territory "yields essentially nothing" for industry. Such industries as do exist are exceedingly small and inconsequential.

While Mortensen appears somewhat pessimistic as to Lithuania's future, a view undoubtedly prejudiced to some extent by his German background, Rutter sees a brighter horizon. The agrarian reform has banished Bolshevism and given agriculture a new life. The government is not only studying agricultural methods abroad but bringing into the country farmers from elsewhere to develop model farms and

[23] H. M. Grove: Report on the Economic and Industrial Conditions in Esthonia. Department of Overseas Trade, H. M. Stationery Office, London, 1925.

[24] J. Lowdon: Report on the Economic and Industrial Conditions in Latvia, Department of Overseas Trade, H. M. Stationery Office, London, 1925.

[25] H. H. Cassells: Report on the Economic and Industrial Conditions in Lithuania. Department of Overseas Trade, H. M. Stationery Office, London, 1924.

[26] Hans Mortensen: Litauen: Grundzüge einer Landeskunde. Osteuropa-Institut in Breslau. L. Friederichsen & Co., Hamburg, 1926.

serve as illustrations to the nationals of what can be accomplished under proper procedure.

Polish Boundary and Memel Territory

Lithuania suffers a special handicap in that her boundary with Poland has not yet been settled, since she refused to accept the line drawn by the Council of Ambassadors in 1923 which gave Vilna to Poland. The fact that there are no relations, political or economic, between Poland and Lithuania has a particularly prejudicial effect on the Memel Territory. Little timber is being floated down the Niemen; and the sawmills, the chief industry of the Territory, are largely idle.

It is difficult to find a concise unbiased account of what actually took place in the transfer of the Memel Territory. An illuminating, though biased, description is given by Rolf Schierenberg.[27] He supports his contention with documentary evidence, but his viewpoint is colored by his intense German patriotism. The dispute was settled by the Convention signed at Paris, May 8, 1924. Article 2 of the Convention[28] provides that the "Memel Territory shall constitute, under the sovereignty of Lithuania, a unit enjoying legislative, judicial, administrative, and financial autonomy" within certain prescribed limits. The Port of Memel is considered as a port of international concern, and the recommendations of the Barcelona Conference are stated to be generally applicable. Naturally enough the affairs of this old German port are not yet in smooth working order. Moreover, apart from questions of administration, there is the need of developing the port for general trade as well as timber export and of providing better communications with Lithuania as a whole. It now is a thirteen-hour journey by rail from Memel to Kovno, and the line crosses Latvian territory.

[27] Rolf Schierenberg: Die Memelfrage als Randstaatenproblem. Kurt Vowinckel Verlag, Berlin-Grünewald, 1925.

[28] League of Nations Treaty Series, Vol. 29, 1924, No. 736.

SOME UNUSUAL SUBMARINE FEATURES IN THE NORTH PACIFIC OCEAN*

Commander N. H. Heck

U. S. Coast and Geodetic Survey

THE rim of the Pacific, including both the shores and the adjacent waters, is one of the most interesting parts of the earth from many viewpoints but especially in that it is the part of the earth where the processes of change to which all the rest of the earth has been subject at one time or another are in most active progress. To describe all the features of interest would require a volume. This paper is intended to bring out some of the less-known features, chiefly submarine.

It was known that along the coast of Mexico and Central America there existed a deep submarine trough, the Acapulcograben of the German charts; but not till the cruise of the Coast and Geodetic Survey Steamer *Guide* in 1923 were the extent and maximum depth of the trough known. This vessel, using the sonic depth finder, was able to make a survey in a short time which, though far from exhaustive, outlined a series of troughs extending from Costa Rica to the Gulf of California with an average width of 40 miles, a total length of 900 miles, and a greatest depth of nearly 3600 fathoms (Fig. 1). While there are much greater deeps, it is noteworthy that on both sides of this trough the depth is very much less than that of the trough, in some cases not more than half.

The earthquake epicenters from the Summary of the British Association for the Advancement of Science 1899 to 1917, from the International Seismological Summary 1918 to 1922, and from records of the Coast and Geodetic Survey after that date were plotted and are shown in Figure 1. Fifteen epicenters are in or near the trough, and half a dozen more may easily have been near it but are located with uncertainty. There is another series which lines up with a series of oceanic islands and reefs, including Guadalupe Island, the Alijos Rocks, and the eastern Revillagigedo Islands. The absence of a deep trough off the California coast and the practical absence of earthquakes except in the seaward continuation of the San Andreas fault are significant.

Passing to southeastern Alaska we note in Figure 3 the outline of what is presumably a volcanic crater, for it is difficult to explain a

* Paper presented before the Geological Society of Washington on March 24, 1926.

circular cavity of such dimensions on any other assumption. The crater lies off Prince of Wales Island.

A geological feature of considerable importance is the pinnacle rock, probably found in greater height off the Alaska coast than elsewhere. Figure 2 shows such a rock exposed to view, but the wire

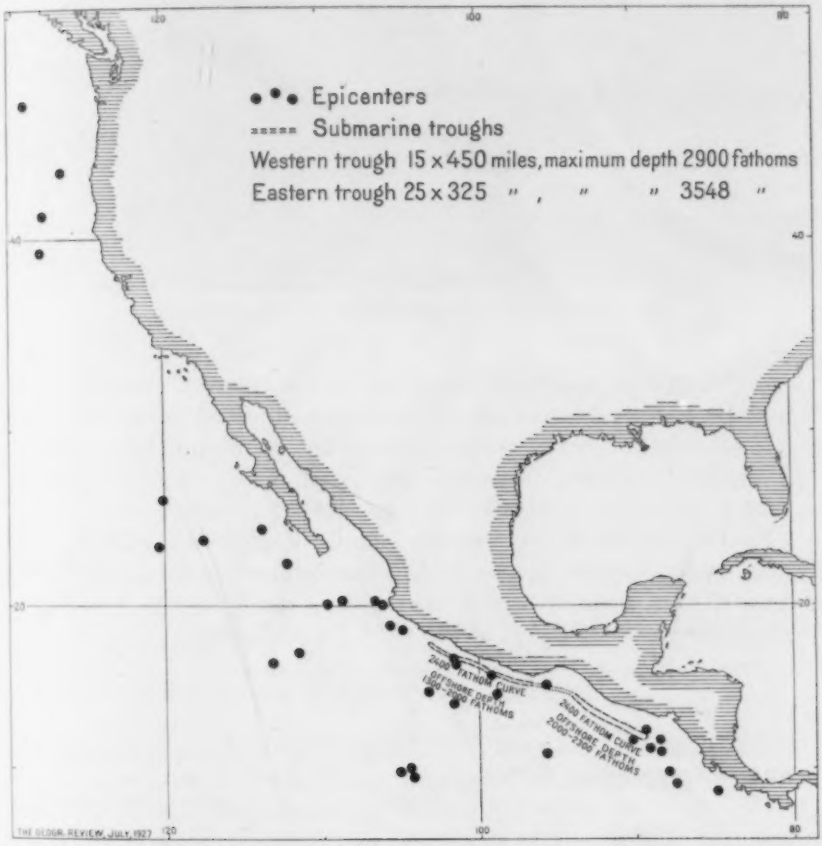
Epicenters
Submarine troughs
Western trough 15 x 450 miles, maximum depth 2900 fathoms
Eastern trough 25 x 325 " , " " 3548 "
2400 FATHOM CURVE
OFFSHORE DEPTH 1900-2300 FATHOMS
2600 FATHOM CURVE
OFFSHORE DEPTH 2000-2300 FATHOMS

FIG. 1—Epicenters off the Pacific coast of the United States, Mexico, and Central America. The submarine troughs off the southern part of these coasts measured by the sonic depth finder in 1923 are also shown. The existence of a connection between the troughs is doubtful but possible.

drag work of the Coast and Geodetic Survey has established the existence of a considerable number of these rocks as submarine features. One of these is 600 feet in height, extending from a bottom of general depth of about 100 fathoms nearly to the surface. Fortunately for navigation, the Coast and Geodetic Survey has dragged all the main channels, so that possible danger of sudden destruction of vessels from this cause is confined to some of the unsurveyed bays.

Yakutat Bay is famous for the great vertical displacement that occurred there at the time of the earthquake in 1899. The change

FIG. 2—Pinnacle rocks near Cape Spencer, Cross Sound, Alaska.

of height, 49 feet, was in solid rock and is the greatest known in such material; the greater submarine changes mentioned later were, undoubtedly, in poorly consolidated materials. In Bristol Bay north of the Alaska Peninsula, Besboro Island, obviously part of the rim of a crater, now rises to 1600 feet in a generally flat region.

Passing west along the Aleutian Islands, Bogoslof Island is the one island under United States jurisdiction whose making has been witnessed, the eruption which caused it to rise from the sea having been observed by members of the U. S. Coast Guard.

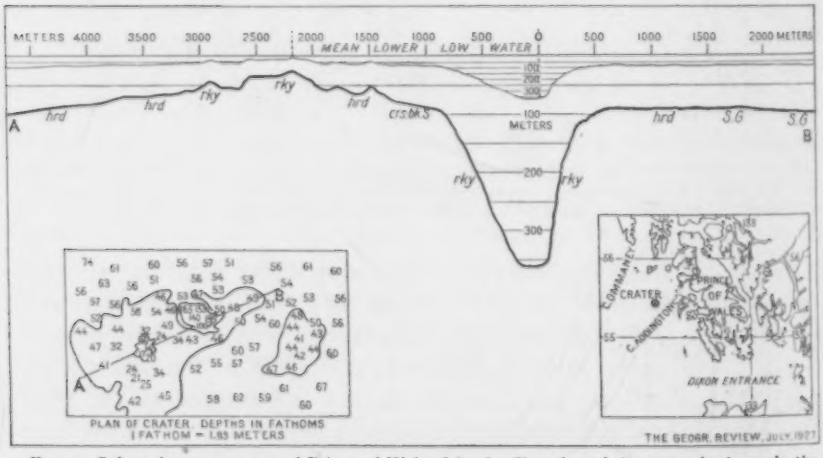

FIG. 3—Submarine crater west of Prince of Wales Island. Situation of the crater is shown in the inset map on the right: a map of the crater appears in the inset on the left. The section across the crater is along the line A–B of the plan. The upper (light) line is drawn to true scale: in the lower (heavy) line the vertical scale has been exaggerated five times.

In Figure 4 the axis of a great deep that parallels the Aleutian Islands is shown. Our knowledge of this deep is based on not more than twelve soundings; but, as all of these are more than 4000 fathoms and all line up properly, there seems little doubt as to the continuity. It is of special interest that this deep apparently continues to the

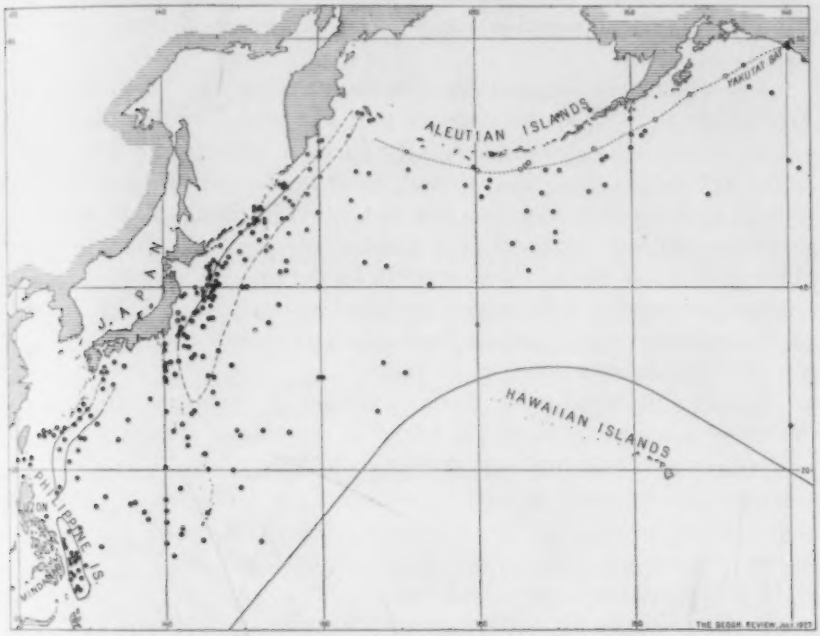

FIG. 4—Epicenters of the north Pacific Ocean. Earthquakes occurring south of the line about the Hawaiian Islands have not been plotted. The line of open circles from Yakutat Bay paralleling the Aleutian Islands represents soundings which define the axis of a great deep.

coast of Alaska following a submarine valley to Yakutat Bay. It will be seen from Figure 4 that a number of epicenters are associated with this deep, especially on its southern edge; while these are few compared with the deeps on the western side of the Pacific, an unusually large proportion are of the world-shaking type.

Little is known as to the character of the bottom between the Aleutian and the Hawaiian Islands, and it is difficult to understand the wide distribution of epicenters in what should apparently be a flat ocean basin.

The association of epicenters with the deep troughs is well brought out in the great trough extending from northern Kamchatka to the southern part of the main Japanese group. It is, of course, true that there are many epicenters inshore from these deeps and also on the land, but it is without argument that the deeps are closely associated with major earthquake activity. The features that have been discussed bring out strongly the need for more detailed surveys of the

North Pacific, especially as immense regions are still without a sounding. With echo-sounding available, the excuse for such a situation no longer exists.

The deep east of the Philippines, which has one of the deepest soundings known, is particularly interesting in that all the epicenters occur in the deep. Earthquakes occur on land in considerable numbers, but almost invariably the greater ones are associated with the Mindanao Deep.

The change in Sagami Bay, accompanying the earthquake of September 1, 1923, is the greatest that has been known to have occurred in a single earthquake. By surveys before and after, it is fairly well established that, though some of the early conclusions of almost unbelievable changes are not fully justified, changes of as much as 100 feet occurred in a number of cases and much greater changes in a few cases. It appears to be the opinion that these great changes occurred chiefly in soft material probably of volcanic origin, as the adjacent rocky shores were changed in few cases more than ten feet, the average being much less.[1]

Another illustration of the advantage of accurate surveys in detecting submarine changes is found in the case of a sudden change of depth in the Zulu Sea near the Cuyo Islands, when an area of half a square mile dropped an average extent of 100 feet between two surveys eighteen months apart. This case is described in full in an article in the *Geographical Review* for April, 1926, by Lieutenant Commander F. H. Hardy of the Coast and Geodetic Survey.

In order that geologists and geographers may be able to attack in an adequate manner the problems of the Pacific it is obvious that deep-sea surveys extending over the entire ocean and also detailed surveys of the coastal waters are urgently needed so that changes may be detected. Such a survey would have been of great value in the case of the Yakutat Bay earthquake, where there was no adequate survey either before or after. The steady and rapid extension of surveys of hitherto unsurveyed area is removing the probability that this will occur again.

[1] Compare the note "Physiographic Effects of the Japanese Earthquake of 1923" by Professor W. M. Davis, elsewhere in this number of the *Review*.

THE UTILIZATION OF THE COLORADO RIVER

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IN the early development of a country rivers are useful mainly as avenues of travel. They are highways to the interior which lure the adventurer and the pioneer. Later, when the land becomes settled, they may or may not retain this primal use. Now protection is demanded from the ravages of the river, and the property and the life of the riparian settler must be safeguarded. Later, when great cities grow in the basin, heavy demands for water for domestic purposes arise; and power for lighting, transportation, and manufacturing is called for. Of all the uses of the river, which are paramount and which are subservient? If two or more can be developed, which should have the preference? Under what conditions do the uses of a river conflict?

The St. Lawrence River, which directed the travels of Champlain, Hennepin, and Marquette, maintains its preëminence as a highway. Its future development involves a great extension of the facilities of navigation and commerce. Because the Great Lakes form natural reservoirs, flood menaces are insignificant along the St. Lawrence; its falls yield alike scenic beauty and power to turn the wheels of distant factories; from its waters are drawn the domestic water supply of great cities. Yet even this stream, well adaptable to a varied utilization, presents its problems, notably in the conflict over diversion at Chicago.[1]

The Mississippi River, lying athwart the pathway to the west, has less historic importance. Great areas adjacent to the river are subject to overflows, and a levee system to protect property and life has been devised, which under normal flood conditions is successful. Levees are not generally constructed to cope with unusual flood conditions such as occurred in the lower Mississippi Valley in the spring of this year (1927). The Mississippi became a highway, but traffic was never large and has declined.[2] At high water the wash of the boats is at times dangerous to the levees, and navigation at these times becomes subservient to protection. Navigation is likewise hampered by low water stages of the river. There are no natural reservoirs, as there are in the St. Lawrence System, and the building

[1] Compare P. W. Henry: The Great Lakes-St. Lawrence Waterway, *Geogr. Rev.*, Vol. 17, 1927, pp. 258–277.

[2] Robert M. Brown: Our Waterway Requirements, *Geogr. Rev.*, Vol. 5, 1918, pp. 119–126.

of artificial reservoirs to withhold the flood waters and to raise the low water stage is, in view of the light traffic, not considered a profitable enterprise. The great dam at Keokuk, Iowa, is an example of the use of this stream for power purposes. The Mississippi River as now regulated under normal conditions fulfills most of the uses of a river without conflict, and with sufficient funds it could perform all.

But these streams are in the humid belt with an ample supply of water, and the question of priority of rights is less apt to arise under these conditions. In the case of the Colorado River in the arid Southwest, it would seem that there is not an ample supply of water for all purposes. In addition to the demand for domestic uses within the basin two large population centers outside of it look here for a means of satisfying their growing needs, and there is a call for water for irrigation and power. Flood ravages and low water stages are halting development. Navigation, which at one time was carried on to some extent between the Gulf of California and the old town of Callville at the lower end of Boulder Canyon, is not an issue on the Colorado as the shifting sands make such travel uncertain.

On the Tennessee River the government built as a war measure the Wilson Dam at Muscle Shoals. This great power plant is today an economic waste because there has been injected into the issue the question of the distribution of power. It is widely conceded that power developed on any stream should belong to the region and should not be monopolized by a few industries. It is obviously wrong that there should be local monopolization of the Niagara River power while the city of Buffalo uses steam-generated power. The main problem in the Southwest, the proper utilization of the waters of the Colorado River, is somewhat befogged by the issue of government ownership of power-generating plants. Meanwhile, the prosperity of the irrigated lands, such as the Imperial Valley, is threatened, and conditions in seven states in the Colorado basin are growing more acute. Furthermore, the Colorado is an international stream.

The Basin and River

The basin of the Colorado River, comprising 244,000 square miles, or 156,160,000 acres, may be divided into three distinct regions. An upper basin in Colorado, New Mexico, Utah, and Wyoming lies between the Wasatch and the Rocky Mountains, and these ranges with their heavy precipitation, especially in the form of snow, supply over 75 per cent of the flow. Over the valleys of the upper basin the rainfall at places is less than ten inches, but with irrigation the valleys are well adapted to agriculture and with power to manufacture.

The plateau section, extending from Lees Ferry to Grand Wash Cliffs, has a general elevation of 5000 to 8000 feet, is cut by deep gorges

and canyons, and is in the main inaccessible. No part of this area is easy of irrigation: the chief characteristic of the region is the fall of water, 2500 feet in less than 500 miles, and the possibility thereby of concentrated water power sites.

The lower basin in the states of Arizona, California, and Nevada and in Mexico, for the most part only a few feet above sea level, is arid with an annual precipitation ranging from an inch and a half to eight inches a year and temperatures ranging from 32° to 120°. In the Salton basin a temperature of 130° F. has been recorded.[3] The potentiality of the lower basin rests entirely on crops from irrigation. The greater portion of the irrigated area lies in Imperial Valley, as the cultivable portion of the Salton basin, is called. This region is separated from the actual basin of the Colorado by a deltaic ridge built up by the river itself. The basin, which occupies a million or more acres, is below sea level and a hundred feet below the Colorado River. The natural and easy possibilities of irrigation began to attract settlement here a quarter of a century ago. By 1910 Imperial County, California, had a population of 13,591, in 1920 of 43,453. The annual value of products raised in the Valley today amounts to between $40,000,000 and $50,000,000.

FIG. 1—The drainage basin of the Colorado River. Scale 1 : 17,500,000.

The prosperity of the area is constantly threatened by the danger of inundation during floods.[4] There is also some concern over water shortage during dry seasons. In 1924 a loss totaling millions of dollars was sustained by the farmers in the Imperial Valley because of lack of water. Table I, prepared by the U. S. Bureau of Reclamation,

[3] John S. Brown: The Salton Sea Region, California, *U. S. Geol. Survey Water Supply Paper 497*, Washington, 1923, p. 13.

[4] For a recent discussion of the instability of conditions in the Colorado Delta see Godfrey Sykes: The Delta and Estuary of the Colorado River, *Geogr. Rev.*, Vol. 16, 1926, pp. 232–255. For special reference to the Imperial Valley see J. H. Gordon: Problems of the Lower Colorado River, *Monthly Weather Rev.*, Vol. 52, 1924, pp. 95–98.

gives irrigated and irrigable areas of the entire basin of the Colorado on the basis of the latest data available.

The Colorado's dominant characteristics lie in its profile (see Fig. 3), and its silt-bearing proclivity. The river is 1700 miles in length and falls 8000 feet, or, eliminating the expectable steep slope of the headwaters from Green River, Utah, to the Gulf of California, 1000 miles, there is a drop of 4000 feet. For half this distance the river flows in a canyon which furnishes innumerable dam sites. When one considers other power-yielding streams in the United States, as the Tennessee River with its Muscle Shoals power site and a drop of 460 feet from Knoxville to Paducah, approximately 700 miles, the potential power of the Colorado appears spectacular. As regards the concentration of water-power sites in North America, only the Columbia and St. Lawrence basins present greater possibilities. According to Bureau of Reclamation estimates at Yuma the river carries about 100,000 acre feet of silt annually. With a flow of 17,000,000 acre feet of water the silt content is approximately 0.6 per cent of its volume.

Irrigation from a high silt-bearing stream is troublesome. As the water passes into the irrigation canals, the reduced velocity of the flow causes heavy deposits in the trenches, and in a short period the capacity of the canals is considerably lessened. The development companies have spent thousands of dollars annually in the Imperial Valley to keep the flow of water in the canal systems in full operation. Dredges are in constant use. A series of dams would reduce the silt-bearing capacity of the river and overcome this trouble. A single reservoir low on the river, as at the Mohave dam site, would protect the irrigation canals from this stoppage; but it is problematical whether or not within a few years the original capacity of the reservoir would be affected if used as a catch basin for silt.

The Colorado Compact

Parts of Wyoming, Utah, Colorado, New Mexico, Nevada, and California and almost the whole of Arizona lie in the Colorado basin (Fig. 1). As already indicated, the interests of the several states in the water of the basin are divergent, and some form of coöperation is necessary for the best utilization of the waters. Under an Act of Congress approved August 19, 1921, the representatives of the states of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming met to determine the allocation of the right to the waters of the Colorado River and signed on November 24, 1922, the Colorado River Compact.[5]

[5] For the text of the document see *67th Congr., 4th Sess. House of Repr. Doc. No. 605*. It may be found also in "The Colorado River Compact," by R. L. Olson (Los Angeles, 1926) which gives a useful analysis of the compact and includes also a considerable body of documentary material.

The Compact names as major purposes "to provide for the equitable division and apportionment of the use of the waters of the Colorado River System; to establish the relative importance of different beneficial uses of water; to promote interstate comity; to remove causes of present and future controversies; and to secure the expeditious agricultural and industrial development of the Colorado

TABLE I—IRRIGATED AND IRRIGABLE AREAS IN THE COLORADO BASIN

(*Areas in Acres*)

	IRRIGATED 1922	ADDITIONAL IRRIGABLE	TOTAL
Upper Colorado Basin	1,447,000	2,740,000	4,187,000
Lower Colorado Basin	521,000	1,467,000	1,988,000
Gila Basin	430,000	400,000	830,000
Totals	2,398,000	4,607,000	7,005,000
Colorado above Boulder Canyon	1,499,000	2,820,000	4,319,000
Colorado below Boulder Canyon	469,000	1,387,000	1,856,000
Gila Basin	430,000	400,000	830,000
Totals	2,398,000	4,607,000	7,005,000
Wyoming	235,000	522,000	757,000
Colorado	800,000	1,460,000	2,260,000
Utah	386,000	377,000	763,000
Nevada	7,000	7,000	14,000
New Mexico	50,000	408,000	458,000
Arizona	493,300	1,312,700	1,806,000
California	426,700	520,300	947,000
Totals	2,398,000	4,607,000	7,005,000

River Basin, the storage of its waters, and the protection of life and property from floods." The area involved is defined as the drainage basin of the Colorado River and its tributaries within the United States and all other territory within the United States to which these waters "shall be beneficially applied." This area is divided into an Upper and a Lower Basin, the dividing point being Lees Ferry, "a point in the main stream of the Colorado River one mile below the mouth of the Paria River."

Under the Compact each of the two basins of the river is apportioned the use of 7,500,000 acre feet of water a year. The lower basin has an additional privilege of increasing its use by 1,000,000 acre feet a year. Provision is also made for the results of any agree-

ment by the United States as to the rights of Mexico to the use of the waters of the Colorado.

The use of the waters for navigation is made subservient to its uses for domestic, agricultural, and power purposes. The Compact provides for the impounding and use of the waters for the generation of electrical energy, but such a use is in turn subservient to the use and consumption for agricultural and domestic purposes.

At the time of the signing of the Compact, the seven states were agreed upon the mutual benefits to be derived from it. Gradually as more facts and conditions were considered there has been a tendency, led by Arizona, to discount the advantages of the main provisions of the Compact.[6] Utah rescinded its ratification early in 1927, and California's adherence is conditional on the building of the Boulder Canyon dam. The Compact, it should be noted, does not make reference to any specific project. In general a vague feeling of impending loss most accurately explains Arizona's attitude. The Fourth Arizona Legislature (1919) created the Arizona Resources Board, with full power to investigate and secure such information as would aid in estimating the amount of irrigable land in the state. The Fifth Arizona Legislature (1921) created a Water Commissioner whose immediate duty was the securing of information as to the possibilities of the development of the Colorado River. Governor Hunt in his message of January, 1923, stated that very little information of a constructive nature is available as a result of these acts.

The Boulder Canyon Project

From a point about 150 miles below El Tovar Hotel on the Grand Canyon the Colorado River for another 150 miles forms the boundary between the states of Nevada and Arizona. The country along this stretch of the river is rugged, and the river alternately flows through open valleys and canyons. From Mohave City, 238 miles from Yuma, the river continues as the boundary between California and Arizona. The first of the irrigable areas lies at Parker, 152 miles above Yuma. The initial recommendation for the regulation of the Colorado River is the so-called Boulder Canyon project now before Congress. This includes the construction of a dam at Black Canyon or Boulder Canyon "adequate to create a storage reservoir of a capacity of not less than twenty-six million acre-feet of water," a canal "located entirely within the United States" connecting the Laguna Dam or other diversion works with the Imperial and Coachella valleys, and construction for "the fullest economic development of electrical en-

[6] Official Report of the Proceedings of the Colorado River Conference between Delegates Representing California, Nevada and Arizona, at the State Capitol, Phoenix, Arizona, Monday, August 17th, 1925, Phoenix, Ariz., n. d.

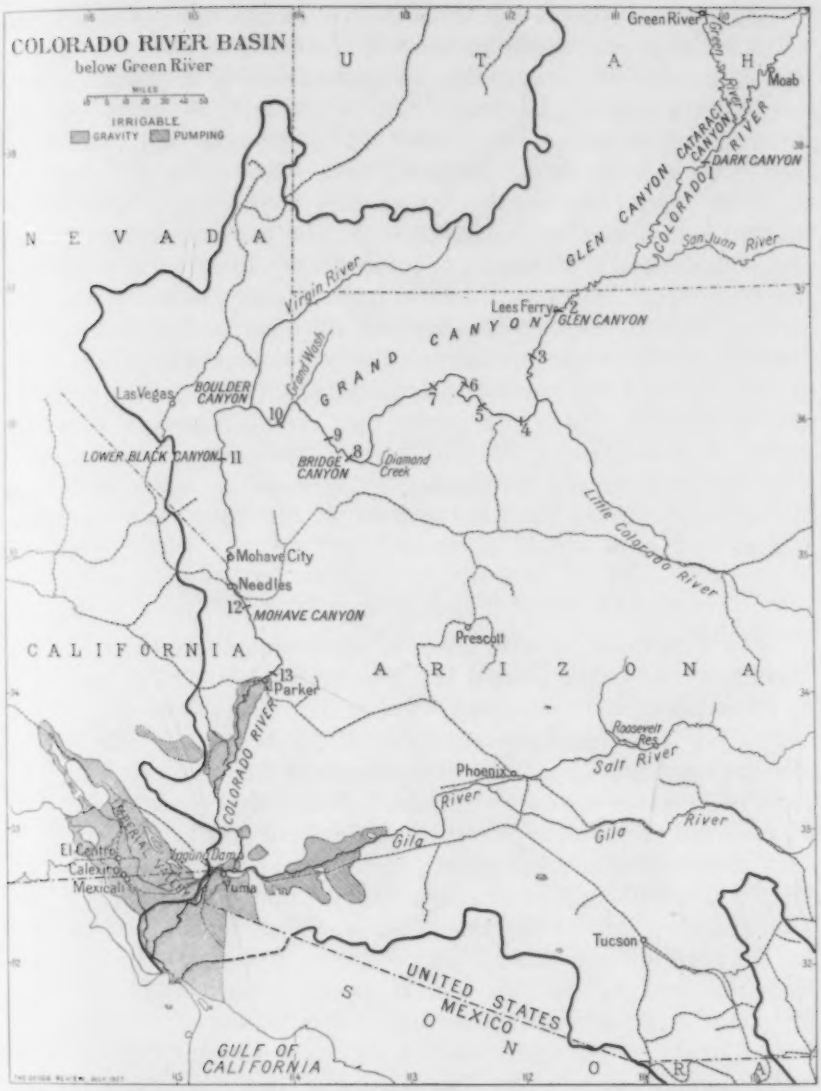

FIG. 2—The Colorado River drainage basin below Green River, Utah. From Pl. II of *U. S. Geol. Survey Water-Supply Paper 556*, by E. C. La Rue (see footnote 10). The numbers have reference to proposed water-power sites: compare Fig. 3 and Table II. Irrigable lands below Parker are shaded, the angle of shading indicating the type of irrigation. Scale 1 : 6,000,000.

ergy."[7] A clause also makes the undertaking contingent on the adherence of "at least six of the signatory states" to the Colorado River Compact.

[7] Colorado River Basin: Hearings before the Committee on Irrigation and Reclamation, House of Representatives, Sixty-ninth Congress, First Session on H. R. 6251 and H. R. 9826 by Mr. Swing: Bills to Provide for the Protection and Development of the Lower Colorado River Basin, Part 2, Washington, 1926, p. 85.

Boulder Canyon is 342 miles above Yuma, Black Canyon 311 miles. The Bureau of Reclamation approves a dam at Black Canyon 550 feet above the river level. To appreciate this magnitude it may be recalled that the Roosevelt dam is 280 feet, the Shoshone 324 feet, and the Arrow Rock 349 feet. The last exceeds the height of any other dam in the world by 14 feet. The cost of the proposed reservoir, ample for the storage of over a year's accumulation of water, is estimated at $41,500,000; of the power development, at $31,500,000; and of the canal, at $31,000,000. The total with interest is $125,000,000. The annual income from the sale of power is estimated at $10,800,000. Need for the proposed all-American canal is stated to depend largely on whether the existing concession under which water is now diverted and carried through Mexico to the Imperial Valley can be modified: "if it can not be then the all-American canal becomes an indispensable part" of the development.[8] The discussions over the Compact and the hearings of the Boulder Canyon bill reveal the difficulties inherent in the problem of the Colorado River regulation.

The Adequacy of the Water Supply

The first question that arises is the adequacy of water in the Colorado basin to the present and prospective demands. In addition to the needs of the basin itself, Denver and Los Angeles are looking to the river as a supplementary water supply for domestic purposes—the one from the Upper, the other from the Lower Basin, which in itself might prove a source of trouble between the two sections.[9] Los Angeles and the group of surrounding cities are particularly insistent, since their continued rapid growth is now threatened by lack of water. With 7,500000 acre feet allocated to the Upper Basin, there is left 8,500,000 acre feet for the Lower Basin. The United States Geological Survey[10] estimates that at Parker, where the water is first turned from the river for use, the annual supply available will be about 9,593,000 acre feet. Irrigable land below Parker and within the bounds of the United States totals 2,304,000 acres, which will demand 9,909,000 acre feet of water. In Mexico at least 1,000,000 acres are irrigable and would require 3,357,000 acre feet. Requirements of southern California for domestic uses are placed at 2000 seconds feet of water, equivalent to an annual total of 1,448,000 acre feet. Thus the total amount which the present-day conditions anticipate is 14,714,000 acre feet; and if the estimates are correct, there will be an annual shortage of 4,805,000 acre feet of water in the Lower Basin.

[8] Report by Secretary Work quoted in *New Reclamation Era*, Vol. 17, 1926, p. 21.

[9] Olson points out a certain "sectionalism" between the western and eastern divisions of the state of Colorado itself, *op. cit.*, p. 177.

[10] E. C. La Rue: Water Power and Flood Control of Colorado River below Green River, Utah, *U. S. Geol. Survey Water-Supply Paper 556*, Washington, 1925.

Inadequacy of the water supply for the Lower Basin and fear that an insufficient amount of water would be allocated to the state are the basis of Arizona's protest against the Colorado Compact and its determination to oppose the Swing-Johnson Boulder Canyon bill. In his message to the Sixth State Legislature Governor Hunt of Arizona stated that the allocation of 4,000,000 acre feet of additional water to the Upper Basin (the present use is about 3,500,000 acre feet) would be an economic waste and that grave injustice is done to Arizona in the apportionment of the waters. The Colorado Compact, on the other hand, states after apportioning the waters between the Upper and Lower Basins that the states of the Upper Division shall not withhold water which cannot reasonably be applied to domestic and agricultural uses.

Water Rights in the Arid West

By common law, if no specific provisions to the contrary have been enacted, an owner of land immediately adjacent to a non-navigable stream owns the bed of the stream to the middle of the current. In this primary consideration it is held that the land only is owned, not the water in the stream, since water is not deemed capable of private ownership. A riparian owner, however, is granted the right to use the waters of a stream flowing through his land in any way and to any extent that does not inflict substantial damage on other riparian owners. The interpretation in many communities has made this right applicable to use on that land only which is adjacent to the stream.

When irrigation began to be extensively practiced in the West and water was desired at a distance from the river, and when water began to be used for mining operations at locations apart from streams, the common law idea was by general consent broadly interpreted, and those who first appropriated water on the public lands and for mining were recognized as the owners of such waters. Later, by Act of Congress and by the statutes of various western states, this idea was incorporated into law. This principle of first appropriation is now the dominant basis of water rights in the arid West. Only in California is the doctrine of riparian ownership recognized—along with that of prior appropriation. Since there appears to be a dearth of water in the Lower Basin, it is not strange if the Lower Basin states look with apprehension upon the proportion of water allocated to the Upper Basin: and particularly since the principle of first appropriation carries with it in the popular mind a title in perpetuity.

The land in Arizona below Boulder Canyon capable of irrigation lies adjacent to the river in small parcels ranging from 200 acres, just below Eldorado Canyon, to 115,000 acres for the Yuma project. The total acreage of this land is 287,200; and the rate of 4 acre feet

per acre for irrigation would require 1,148,800 acre feet of water annually. This could be obtained probably without difficulty from the annual supply estimated at Boulder Canyon of 9,610,000 acre feet; but Arizona is not sure that this is all the land that can be irrigated. Two projects,[11] the Parker-Gila Valley and the Arizona High Line Canal, may some day be feasible. The former will irrigate 765,000 acres in Arizona, and the latter 2,350,000 acres; together 3,115,000 acres, for which the entire annual supply of water at Boulder Canyon would be insufficient. At the present time the pro rata cost per acre of these projects is prohibitive.

Arizona declares her wish to stand by the law of prior appropriation, and she fears that in signing the Colorado Compact she will be signing away her future rights to utilize the resources of the Colorado River. She insists on her right as a sovereign state to maintain jurisdiction over the bed of the streams within her borders and over all the water that flows within her boundaries except as title has been acquired under existing laws.

International Complications

The Colorado River runs 110 miles through Mexican territory before emptying into the Gulf of California. The contract by which Mexico could claim one-half of all the water passing through the American-Mexican canal is now working hardships on the builders of the canal and the Imperial Valley cultivators. American irrigation companies financed the canal, built it, are maintaining it, and policing the levees. They are hampered in their maintenance, even to the extent of paying tariff charges on mules moved across the border for work on the canal. There is growing out of these conditions a feeling of injustice and particularly a fear that the American-Mexican canal in the future is not going to serve the Imperial Valley adequately.

Recently a large Spanish grant in Mexico was bought by an American syndicate, largely made up of Los Angeles financiers, and this grant is being placed under irrigation rapidly. Oriental laborers are employed at a very low wage, taxes are lower than in the United States, and water is cheaper; the combination produces cheaper goods on the Mexican side than on the American. Competition of this kind can be regulated, since the international border line separates the two; but the extension of irrigable lands in Mexico has limited and will continue to limit the amount of water received by the Imperial Valley cultivators through the American-Mexican canal, and heavy losses have been sustained, as in September, 1924, when the crops perished because of an inadequate water supply. And this promises to be more common in the future, unless relief comes.

[11] Report Based on Reconnaissance Investigation of Arizona Land Irrigable from the Colorado River. Arizona Engineering Commission, 1922, 1923.

The situation becomes complicated and passes into the realm of manipulative special privileges. Arizona and Utah fear that California is seeking some advantage over the other states. The dissatisfaction over the Mexican agreement in the allocation of water in the American-Mexican canal, in the face of the fact that southern California interests are expanding Mexican lands, is, however, much less international than appears on the surface.

The Colorado Compact provides for future contingencies by assigning Mexico such waters as are surplus over the allotments to the Upper and Lower Basins; and, further, should the United States recognize at any future time the right to the use of more water, this additional water shall be taken share and share alike, from the assignations to the Upper and Lower Basins.

Flood Control

That there is an immediate need for the flood protection of the Lower Colorado Basin and the Imperial Valley is scarcely to be questioned. The Boulder Canyon dam as proposed in the Swing-Johnson bill would take from five to ten years to complete. It is a comprehensive scheme designed to serve four purposes—flood control, irrigation storage, silt storage, and power development. A scheme on a comparable scale has not been tried before, and there is disagreement as to its merits.[12] Other expert engineering opinion favors separation of the problems of flood control and irrigation storage from that of power development for a more efficient use of the available water supply.[13] Three sites have been proposed for purely flood control reservoirs: Mohave Canyon, Glen Canyon, and Black Canyon.

The Glen Canyon[14] site, 680 miles above Yuma and above the Grand Canyon, would store 8,000,000 acre feet of water. Although it would not control the floods on the tributaries below its location, it is not believed that such floods would be a menace. The main advantage of this site lies in the power possibilities of the river, and it would be one of a chain of dams for such development (see Table II). If power is not to be developed it is inferior to the others as a flood-control site. This dam could be constructed in six years at a cost of $77,000,000.

Black Canyon site is 340 miles above Yuma and in close proximity to Boulder Canyon. Here again the question of power enters, and if it is deemed advisable to develop the Colorado as a power stream it

[12] Secretary Work announced on March 14, after failure of Congress to pass on the Boulder Canyon bill, that a "fact-finding" committee would be appointed to advise the government on the merits of the Colorado River development projects.

[13] La Rue, *op. cit.*, p. 71.

[14] Figures covering the description of these dam sites for flood control as well as the dam sites for power are taken for the most part from the paper cited in footnote 10.

would be unwise to neglect the Boulder Canyon site. The dam at Black Canyon, which would furnish ample flood protection, would also take six years; but the cost would be considerably less, $28,000,000.

The Mohave Canyon site is 202 miles above Yuma, and here a dam could be constructed in three years at an approximate cost of $26,000,000. It would have the same storage capacity as Black Canyon, 10,000,000 acre feet, and additional storage could be provided at a less cost than at any other site; at the same time it would more adequately protect the irrigated areas from flood than any other site. The Mohave reservoir would flood some lands that are irrigable;

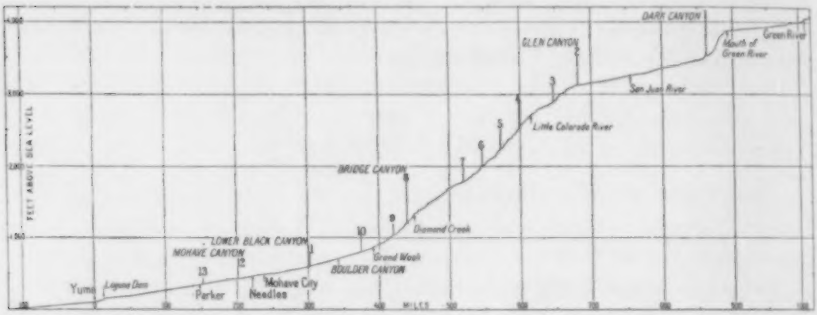

FIG. 3—Profile of the Colorado River below 4000 feet showing proposed dam sites. From Pl. III of *U. S. Geol. Survey Water-Supply Paper 556*, by E. C. La Rue (see footnote 10). Compare Fig. 2 and Table II.

but, since there are more such areas than there is water to serve them, the point is negligible. The town of Needles (population 2807) is situated in the reservoir area and would have to be transplanted. If flood protection alone is desired the Mohave Canyon reservoir appears to be the one preëminently fitted to meet this need.

WATER POWER

The full development of the water power of the Colorado River cannot at present be undertaken because of the enormous cost. At the same time it would be an unwise move so to regulate the flow of the river that future water-power construction is hindered or decimated, especially since adequate protection from flood may be obtained from a number of reservoir sites coördinated with the power plan.

The thirteen-dam plan for the development of power would yield a 3588 foot fall of water in 700 miles, as shown in Table II, with which should be compared Figure 3.

The total cost of all this construction would probably be prohibitive, at least for some time.[15] There is in addition the question of

[15] The Federal Power Commission has been reported as opposed to dams on the Colorado River for power generation. In reality it is not, but it has suspended action on all applications except one at Diamond Creek until a settlement is made of the interstate compact so that licenses which are issued may be in accord with the terms of the compact.

the demand for this amount of power in the region. Arizona, with a population density of 1.7 per square mile, offers by these projects a horse power of 50 per square mile: New England with a population density of 98 uses on the average 62 horse power per square mile.

TABLE II—SUGGESTED POWER DEVELOPMENT ON COLORADO RIVER BELOW ELEVATION OF 4000 FEET

DAM SITE	HEIGHT OF DAM IN FEET	HORSE POWER	MILES ABOVE YUMA
1. Dark Canyon . . .	512	672,000	862
2. Glen Canyon	386	557,000	682
3. Redwall	222	362,000	647
4. Mineral Canyon . .	345	588,000	600
5. Ruby Canyon . . .	286	495,000	573
6. Specter Chasm . . .	223	392,000	547
7. Havasu	209	387,000	520
8. Bridge Canyon . . .	566	1,090,000	440
9. Devil's Slide	163	311,000	421
10. Hualpea Rapids . .	225	483,000	375
11. Lower Black Canyon	194	375,000	303
12. Mohave Canyon . .	158	storage	202
13. Parker Canyon . .	99	70,000	154
	3588	5,792,000	

Southern California is mentioned as a market for much of the power. From Needles, on the Mohave site, to San Bernardino is 160 miles; to Los Angeles is over 200 miles; while the upper dam sites are more than 300 miles away. The famous transmission lines carry power no such distance: the Pacific Light and Power Company at Los Angeles transmits power about 250 miles; the Ausable Electric Company, Michigan, 245 miles; the Hydro-Electric Power Commission on Ontario, 135 miles; and the Mississippi River Power Company, 144 miles. For long-distance transmission the voltage must be high—the companies mentioned operate at from 110,000 to 150,000 volts—and this increases the cost of transmission lines.

CONCLUSION

An attempt has here been made to show the many sides of the Colorado regulation question. The advocates of one or another policy are many of them honestly trying to solve the problem to the greatest advantage. That there is some attempt by a few to drive a sharp bargain does not particularly affect the situation. There are

flood protectionists who see only the need of impounding the water; there are power advocates who dislike to see the waste of energy; and there are water-supply protagonists who desire the cultivation of all the irrigable lands that can possibly be brought to blossom. To this triumvirate may be added the sectional groups somewhat dominated, as is natural, by jealousy and suspicion, and then the problem of the Colorado River is before us.

GEOPHYSICAL PROBLEMS OF GENERAL INTEREST

A SURVEY OF RECENT LITERATURE

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SOME of the most abstruse problems that confront students of earth sciences concern the constitution, structure, and physical behavior of the inner earth. The interest and importance of these matters are far-reaching, as the major surficial features of the globe, on which depend the welfare and the very existence of man, will never be understood properly without knowledge of the invisible interior. Quite certainly the great surface inequalities—ocean basins, continents, plateaus, and mountains—are not the result of mere chance. They reflect conditions and forces in the deeper zones of the earth, far beyond the range of direct observation. What is the mechanism by which large relief features have been made and maintained? What has been the relation of continents and oceans in the past? Recent attempts to answer these stubborn questions use data from geology, physics, chemistry, geodesy, mechanics, and seismology, with a generous admixture of assumption. As might be expected, the results are widely at variance. However, the discussions from various viewpoints reveal a considerable body of accepted fact and inference.

Views of Jeffreys

Outstanding among the recent geophysical contributions is a British book with the comprehensive title "The Earth," by Harold Jeffreys.[1] In this work mathematics and lucid English are combined very happily, so that readers who find the mathematical treatment too formidable may do judicious skipping and still follow the main argument. Starting with cosmogonical considerations, Jeffreys rejects the Laplacian hypothesis as to the origin of the solar system and adopts the idea of tidal solar disruption which was brought into prominence by Chamberlin and Moulton and later modified by Jeans. Jeffreys thinks it probable that the disrupted gaseous material formed rapidly into a few large spheroidal bodies, which condensed to the liquid state and, in the case of the smaller masses, finally solidified. Thus his hypothesis insists on a liquid stage in the earth's history—a view

[1] Harold Jeffreys: The Earth: Its Origin, History and Physical Constitution. Cambridge University Press, 1924.

favored by many geologists. Proceeding from this stage, Jeffreys deduces the later thermal history. Heat was dissipated by convection and radiation, and solidification occurred in comparatively brief time, starting at the center and progressing outward. After the solid state was reached, further cooling by conduction was extremely slow, and up to the present there has been essentially no lowering of temperatures below a depth of 700 kilometers. Nevertheless cooling in the outer shell has had profound effects. Assuming certain initial temperatures, Jeffreys attempts to show that thermal contraction has been sufficient to produce all known mountain structures.

This serious revival of the thermal contraction theory has been surprising to geologists, as the conclusions of Osmond Fisher caused general abandonment of this theory many years ago. Jeffreys points out the fallacy in Fisher's reasoning and submits quantitative calculations that are impressive but not wholly convincing, as the values taken for shortening in mountain zones are much too small. In a later paper [2] Jeffreys recognizes this deficiency but suggests that his original estimate for total crumpling by contraction may be increased considerably on certain plausible assumptions. It is possible, therefore, that thermal contraction has been responsible for at least a large part of mountain folding.

The continents are granitic and stand well above the level of ocean basins, which are floored with heavier rock. On the basis of the average content of radioactive minerals in continental rocks, Jeffreys estimates that the thickness of the granitic layer is approximately sixteen kilometers.[3] A comparable thickness is indicated by seismological data. The suggestion is obvious, therefore, that the continents are comparatively thin plates resting upon a substratum of more basic material. But how shall we account for the limited area and peculiar distribution of the continents? It would seem that materials of low density segregated from a molten earth should form a nearly uniform layer over the entire surface. Actually, the granitic plates occupy only one-third the surface area and are for the most part confined to one hemisphere. Both of these facts present serious difficulties under any hypothesis of earth origin. Jeffreys offers suggestions but evidently without conviction, as he states in his last paper "There is at present no explanation of the origin of continents that can be regarded as even remotely satisfactory."[4]

[2] *Idem:* The Earth's Thermal History, and Some Related Problems, *Geol. Mag.*, Vol. 63, 1926, pp. 516–525.

[3] Holmes and Lawson discovered recently that the radioactivity of potassium is appreciable (Arthur Holmes and R. W. Lawson: Potassium and the Heat of the Earth, *Nature*, No. 2948, Vol. 117, 1926, May 1, pp. 620–621). In view of this discovery, Jeffreys now thinks that his estimate of sixteen kilometers is too large (The Earth's Thermal History, p. 518). A reëxamination of seismological data leads him to suggest that the granitic layer averages 12 kilometers in thickness and that the underlying basaltic layer is 25 kilometers thick (Harold Jeffreys: On Near Earthquakes, *Monthly Notices, Royal Astronom. Soc., Geophys. Suppl.*, Vol. 1, 1926, pp. 385–402.

[4] *Idem:* The Earth's Thermal History, p. 522.

Geodetic data show beyond question that surface inequalities, such as mountain systems, are compensated by differences in average density within a comparatively thin shell. Jeffreys conceives that adjustment for shift of surface load occurs by flowage in a zone of small or zero strength. The strong crust above this zone is much thicker than the granitic layer alone and not identical with it as was assumed by Airy. However, Jeffreys considers that Airy's "roots of mountains" theory is preferable, on geologic grounds, to the Pratt assumption of uniform distribution of compensation to a constant depth.[5] Present geodetic data cannot distinguish satisfactorily between the two forms of compensation, and Bowie's criticism of Airy's theory does not appear to be justified.[6]

Some German scientists have studied the question of isostasy with great care. Otto Meiszner, a student of the master Helmert, points out that geodesists generally favor the Pratt conception of compensation, whereas most geologists prefer Airy's idea of a light crust with variable thickness.[7] In Meiszner's opinion, the Pratt hypothesis has more in its favor than mere convenience of computation; but he concedes that the Airy conception is supported by seismologic evidence. Isostasy is an established principle, but the nature of density distribution remains to be determined by accumulation and study of more data.

T. C. Chamberlin is impressed with the evidence of elastic solidity in the earth, and he proposes that we describe the balancing between earth segments as *elasticostatic* or *elastatic* instead of isostatic.[8] It is evident that his criticism goes deeper than mere terminology and involves a fundamental difference in point of view. In support of his contention he cites the response of the earth to tidal forces and to seismic shocks, the nature of nutation, and the implication of the major geologic processes. He does not discuss the data from geodesy bearing on the compensation for topography by differences in density.

Joly's Contribution

Jeffreys' book gives an impression of soundness and care, thereby inspiring confidence in his conclusions. However, much of his argument concerning conditions in the outer earth rests on the assumption of continuous cooling—except in pockets of magma generated locally—since the original solidification. Joly has raised serious doubt as to the truth of this assumption. In his recent book, "The Surface-History of the Earth,"[9] he tries to show that heat accumulating from

[5] *Idem*: On the Nature of Isostasy, *Gerlands Beiträge zur Geophysik*, Vol. 15, 1926, pp. 167–188.

[6] William Bowie: A Gravimetric Test of the "Roots of Mountains" Theory, *U. S. Coast and Geodetic Survey Serial No. 291*, 1924.

[7] Otto Meiszner: Zur Isostasiefrage, *Petermanns Mitt.*, Vol. 72, 1926, pp. 262–263.

[8] T. C. Chamberlin: Intrageology—Elastasy vs. Isostasy, *Journ. of Geol.*, Vol. 35, 1927, pp. 89–94.

[9] John Joly: The Surface-History of the Earth. Oxford University Press, 1925.

radioactive disintegration in the rocks must cause periodic fusion in a universal subcrust. The reasoning is quite plausible and is backed by quantitative computations. Granitic rocks at the surface have a certain average content of uranium and thorium. Basaltic rocks also contain these elements but in smaller amounts. Uranium and thorium break down at a known rate, developing a supply of heat that would be easily calculable if we knew the distribution of the radioactive elements in depth. Geophysicists are agreed that these elements are confined to a surficial layer of moderate thickness, as their distribution to great depths would result in permanent fusion. Joly believes that the best data from seismology and geodesy indicate a thickness of about thirty kilometers for the continental plates. Assuming uniform distribution of radioactive elements throughout these granitic masses, he computes that the heat generated by disintegration is almost identical with the heat escaping at the surface, as determined from the geothermal gradient and the conductivity of rocks.

But the plateau basalts, which presumably arose from the basic stratum beneath the continents, also contain measurable amounts of the radioactive elements. Joly reasons, therefore, that heat accumulates in the substratum until widespread melting occurs. With fusion the density of the basic layer decreases, and consequently the continental plates sink to a lower level, permitting seas to flood the lowlands. Under the oceans fusion of the subcrust begins at greater depth than under the continents; but, once it starts, melting proceeds upward until the suboceanic crust is thin enough to permit escape of the surplus heat into the oceanic water. While the entire substratum is liquefied the solid crust, retarded by the tidal brake, slips slowly over the rotating interior; and therefore in time the cooling effect of the oceans is enjoyed by all parts of the liquid layer. Eventually the surplus heat is dissipated, and as the substratum solidifies its density increases to normal, forcing the floating continents upward to their former level.

Under this bold and picturesque hypothesis, therefore, the world-wide emergences of geologic history, succeeding epochs of general submergence, would occur as a logical consequence of isostatic principles. The hypothesis also accounts for other major geologic events. Expansion of the melting substratum would develop tension throughout the lithosphere, and rifting on a large scale would occur. Basic magma would rise to fill the fissures, and in favorable localities the magma would be forced to the surface in large quantities. Contraction of the subcrust on universal cooling would necessitate collapse of the enlarged outer shell, with consequent wrinkling and thrusting. Repetitions of the melting in widely separated geologic periods would explain the cyclic recurrence of diastrophism and major igneous ac-

tivity. Considered qualitatively, therefore, the hypothesis is very successful from the geologic standpoint.

Reactions to the Joly Hypothesis

Joly's views, in their essential aspect, have a staunch supporter in Holmes, whose ideas on the subject are outlined in a recent paper.[10] He seeks to supplement Joly's presentation, which he finds "too simple to match the complex details of geologic history." His own discovery, with Lawson, that potassium has important radioactive properties suggests that the average thickness of continents is not over fifteen kilometers—an estimate in close accord with that of Jeffreys. But the substratum, in order to buoy up these thin continents to their present height, must be considerably denser than ordinary basalt; and therefore it is assumed, with Fermor, that the rock of the subcrust exists as eclogite, with average density near 3.5. This layer would behave essentially as postulated by Joly, causing cyclic disturbances of the lithosphere. However, geologic history records a few crustal revolutions of unusual severity and complexity, separated by several milder disturbances. To account for these facts Holmes postulates that the eclogite layer lies above a thick zone of peridotite, which has a high melting point and a low content of radioactive materials. Independent cycles of the eclogite layer affect the lithosphere moderately; but, occasionally, coincident fusion of this layer and the peridotite below, with complicated interactions, brings on a period of profound diastrophism, such as that of the late Paleozoic or the Tertiary.

One point in the original Joly-Holmes theory has met a very proper criticism.[11] On the assumption that the ocean waters rest directly on rock typical of the substratum, a condition of instability would exist after fusion began, as the heavy ocean floors would lie above magma of smaller density. It seems inevitable, therefore, that the floors would founder and that the heat of the fused basalt would be given up quickly to the ocean water, with disastrous results both to marine life and to the completion of the Joly cycle. Holmes admits the force of this criticism but attempts to avoid it by postulating a syenite layer, four to eight kilometers thick, between the ocean water and the basic substratum. Recent seismological data lend some support to this assumption. From the geological viewpoint, inclusion of granitic fragments in volcanic rocks on Ascension Island,[12] in mid-Atlantic, may be considered favorable evidence. No such evidence has been reported from the many basaltic islands of the Pacific.

[10] Arthur Holmes: Contributions to the Theory of Magmatic Cycles, *Geol. Mag.*, Vol. 63, 1926, pp. 306–329.

[11] G. R. MacCarthy: Radioactivity and the Floor of the Oceans, *Geol. Mag.*, Vol. 63, 1926, pp. 301–305.

[12] R. A. Daly: The Geology of Ascension Island, *Proc. Amer. Acad. of Arts and Sci.*, Vol. 60, 1925, pp. 1–80; reference on pp. 63–68.

Jeffreys seems favorably disposed toward the suggestion of a suboceanic syenite layer, but he pronounces Joly's hypothesis of oscillating temperatures out of harmony with physical laws.[13] Joly insists that the heat developed by uranium and thorium makes periodic fusion inevitable. Evans has suggested, however, that a considerable part of the energy liberated by these elements in the rocks "is used up in effecting physical, chemical, and atomic changes in the surrounding minerals."[14] Such changes are indicated by the development of pleochroic haloes around radioactive minerals. This suggestion invites study, but until Evans' criticism is made more tangible it is in no way fatal to the theory of periodic fusion.

Hypothesis of Continental Displacement

Jeffreys admits the possibility that the lithosphere as a whole may lag in rotation,[15] and Joly makes this sort of displacement an essential part of his hypothesis. Taylor and Wegener postulate differential horizontal movements within the lithosphere itself. This radical conception has seized on the fancy of scientists with the fascination of a new toy. Wegener's book has gone through three editions and is now available in an excellent English translation.[16] The author admits frankly that his idea originated in the apparent coincidence of coast lines on opposite sides of the southern Atlantic. The correspondence is truly remarkable but does not in itself constitute any proof that South America and Africa were once adjacent. Wegener seeks evidence in geologic history and in a comparative study of geologic features on opposite sides of the "rift." Certain faunal and floral relationships in the Mesozoic and Paleozoic eras appear to support his view, and present geologic "controls," as interpreted by Wegener himself, make the postulated displacement almost a certainty. Critical study throws considerable doubt on the evidence. On the basis of Wegener's hypothesis we should expect the older faunas on opposite sides of the Atlantic, in areas formerly contiguous, to be nearly identical; but paleontologists find only a small percentage of closely related forms. Although the theory appears to solve some problems of paleogeography it also creates additional difficulties.[17] The physical "controls" match less accurately than Wegener would have us believe.

[13] Jeffreys, The Earth's Thermal History, pp. 520–522.

[14] J. W. Evans: Regions of Compression, *Quart. Journ. Geol. Soc.*, Vol. 82, 1926, pp. lx–cii; reference on p. lxi. See also the reply by R. W. Lawson: Radioactivity and the Heat of the Earth, *Nature*, Vol. 119, 1927, pp. 277–278, and continuation of correspondence, pp. 424–425 and 703–704.

[15] Jeffreys, The Earth, p. 266.

[16] Alfred Wegener: The Origin of Continents and Oceans. Translated from the third German edition by J. G. A. Skerl. Methuen & Co., London, 1924.

The second German edition of Wegener's book was reviewed by Harry Fielding Reid in the *Geogr. Rev.*, Vol. 12, 1922, pp. 672–674.

[17] See for instance L. Joleaud: L'histoire biogéographique de l'Amérique et la théorie de Wegener, *Journ. Soc. des Américanistes de Paris*, Vol. 16, 1924, pp. 325–360; *idem:* Essai sur l'évolution des milieux géophysiques et biogéographiques, *Bull., Soc. Géol. de France*, Vol. 23, 1924, pp. 205–270.

If South America is placed in its assumed former position beside Africa, the Cape Mountains and the Sierras of Argentina do not correspond either in position or in trend. H. S. Washington, reviewing the evidence from petrology along the whole Atlantic border, finds dissimilarities much more striking than the apparent relationships.[18] It is well known that the Hercynian Mountains of Europe represent an older epoch of orogeny than the Appalachians, and therefore the two systems cannot represent a disrupted unit as suggested by Wegener.

Wegener's hypothesis is not strengthened by geophysical considerations, as no known force appears to be nearly adequate to urge the "sial" plates through the "sima." Assumption that length of time compensates for weakness of the forces is not satisfactory, as the "sima" assuredly has high strength to considerable depth beneath the oceans and therefore cannot act as a viscous fluid. Even if we should grant Wegener this point we could not at the same time accept his explanation that mountains are due to resistance encountered by the forward edge of a moving continent, as a substance devoid of strength cannot be expected to develop powerful resistance. Jeffreys tests the hypothesis by a quantitative comparison of forces.[19] The agencies charged with continental movements can exert stresses equal to 10^{-5} dynes per sq. cm.; to elevate the Rocky Mountains, these stresses would have to be multiplied by 100,000,000,000,000. This test cannot be accepted at full value, as Jeffreys has adopted the erroneous assumption that the Rockies were carried to their present height during the time of folding and thrusting. However, deformation of the strong continental rocks to produce mountain structures required powerful forces and could not have been accomplished by puny secular stresses as an incident in displacing enormous continental masses.

Daly, recognizing the requirement of energy to perform the work of transporting continents and folding mountains, has proposed a modification of the displacement hypothesis.[20] He postulates low domes of continental scale, formed slowly in response to internal contraction, to changes in the rate of rotation, and to the effects of secular erosion. Finally the doming creates a condition of instability in the lithosphere, and continental masses slide down the low gradient, moving over a substratum of hot basaltic glass. Weak sediments in geosynclinal basins near the base of the dome are crushed and thickened by the sliding continents. Later expansion of material driven down into the hot substratum causes uplift of the folded sediments into mountains. Daly's hypothesis has the merit that it recognizes ordinary mechanical principles and makes use of older helpful con-

[18] H. S. Washington: Comagmatic Regions and the Wegener Hypothesis, *Journ. Washington Acad. of Sci.*, Vol. 13, 1923, pp. 339–347.

[19] Jeffreys, The Earth, p. 261.

[20] R. A. Daly: Our Mobile Earth. Charles Scribner's Sons, New York, 1926.

ceptions, such as contraction of the earth's interior. Wegener rejects all older ideas of diastrophism as obsolete tools.

The final verdict on all forms of the displacement hypothesis must rest on detailed geological study of critical areas. Eastern South America and western Africa must be examined thoroughly for decisive data. If geologists become convinced, on the basis of future discoveries, that these two continents actually have moved apart, no doubt the geophysicists will take a more active interest in the problem.

Deformation by Rotation

Andrews points out that mountain systems are broad, wave-like protuberances above the general level and that corresponding shallow basins extend roughly parallel to them. He advances the hypothesis that these major inequalities result from slow rock flowage induced by rotation.[21] Waves tend to grow in height; but under the influence of gravity the material spreads out, with the production of thrusts and folds. Thus the hypothesis of mountain making by vertical uplift, repeatedly championed by Bowie,[22] is thought to be consistent with the observed facts of great thrusts.

In order to picture the effect of rotation, Andrews imagines three globes, comparable to the earth in size; one made of steel bands, one of closely fitting sand grains with varying composition, the third of closely fitting rocks differing in chemical composition, form, and strength. These globes are set spinning on axes. In the first, a tendency to flow at depths of a few miles will be checked by the strength of the overlying steel. In the sand globe the strong reactions toward the surface will encounter only the resistance of gravity, and large waves will result, with local melting at depth on relief of pressure. The third globe will behave in similar fashion, but resulting surface forms will be more irregular. The argument is very general, with no quantitative checks; and the conclusions are not convincing. A quantitative treatment is promised for the future.

Andrews believes "that the laws of mountain-building admit of extremely simple statement." It is not obvious, however, that the known orogenic features of the earth bear a simple relation to the forces assumed in the hypothesis. Meridional undulations due primarily to rotation should be conspicuously stronger in the equatorial belt than in middle latitudes and should become insignificant in moderately high latitudes. The American Cordilleras do not meet

[21] E. C. Andrews: Hypothesis of Mountain-Building, *Bull. Geol. Soc. of America*, Vol. 37, 1926, pp. 439–454.

[22] William Bowie: Geology from the Isostatic Viewpoint, *Scientific Monthly*, Vol. 22, 1926, pp. 5–18.

Idem: Proposed Theory, in Harmony with Isostasy, to Account for Major Changes in the Elevation of the Earth's Surface, *Gerlands Beiträge zur Geophysik*, Vol. 15, 1926, pp. 103–115.

Idem: The Part Played by Isostasy in Geophysics and Geology, *Journ. Washington Acad. of Sci.*, Vol. 17, 1927, pp. 101–117.

this expectation. Equatorial Africa is almost featureless in comparison with Alaska and Antarctica. Some of the most intense deformation by thrusting and folding is found between parallels 50 and 80 north. There is no apparent reason, under the hypothesis, for the pronounced east-west trends of Eurasian systems in contrast with the north-south trends of American mountains.

General Comment

From consideration of these diverse conceptions the ultimate cause of diastrophism is seen to be as much as ever the great mystery of geology and a major problem of geophysics. It may even appear, from Jeffreys' revival of the thermal contraction theory, that efforts to learn the secret are moving in a circle. However, it is not fair to conclude that the problem is altogether insoluble or that the various speculative views are without value. Progress in study of the inner earth has been most gratifying, and the large number of recent theoretical discussions may be taken as first attempts to capitalize the new knowledge. Painstaking inductive study must continue to furnish the essential data; but judicious speculation and theory have their place in lending zest to endeavor and in actually guiding attack on critical problems.

The methods of seismology and geodesy may be expected to provide the most significant data for further study of the earth's interior. Experimental work in geophysical laboratories will throw additional light on the behavior of rocks under high pressure and temperatures. Needless to say, the evidence of diastrophism obtainable on the surface of the earth is still woefully incomplete and will remain so until wide regions have been studied and mapped geologically.

THE LOST GLOBE GORES OF JOHANN SCHÖNER, 1523–1524: A REVIEW*

George E. Nunn

THE first volume of Dr. Wieder's "Monumenta Cartographica" contains a reproduction of what is declared to be Johann Schöner's lost globe of 1523–1524. This globe belongs to a most important period of discovery and exploration. It was based in part on information derived from the Magellan voyage. It is an extremely significant link in the cartographical record of the most productive period in geographical history. The globe has been known hitherto only from the letter of Schöner to von Streytpergk and from the partial description in Schöner's "Opusculum Geographicum."[1] In the Streytpergk letter Schöner denies the intention of setting aside one of his earlier globes. Instead he maintains that, so far as it goes, the earlier globe agrees with the later one. The "Opusculum Geographicum" contains some information concerning Schöner's ideas of American-Asiatic geography with which the globe of 1523–1524 should conform.

Criteria for Identification

Henry Stevens of Vermont thought that he had identified the globe with the Rosenthal gores. Nordenskiöld and others, however, have not accepted these gores as the real Schöner globe. The evidence on the Stevens' Schöner may be summarized: affirmatively, it is a gore map showing the track of the Magellan expedition and belonging undoubtedly to a time not long after Magellan; negatively, there is a separation of the Americas from Asia by a long narrow strait debouching into the Atlantic north of Bacalaos, and the map does not contain the names in Schöner's "Opusculum Geographicum," wherein the American geography is completely merged with the Asiatic. Nordenskiöld thought that the Stevens map belonged to a period about 1540.[2] However, as Heawood[3] points out, it has since been shown by Miss Mary Hervey that Holbein used this map in a painting in the year 1533.

Dr. Wieder's map contains the American-Asiatic geography in conformity with the "Opusculum Geographicum." South America is made a peninsula of the Asiatic continent. Temistitan, or Mexico City, is identified with the Quinsay of Marco Polo and is situated on a lake. The city is placed approximately in longitude 226° E. and latitude 21° N. in conformity with the "Opusculum Geographicum."[4] The names Mangi, Cathay, and Asia are located side by side with Messigo, Parias, and Urabe. With two or three exceptions all of the names mentioned in Schöner's book are found on this map and in such an order that there is in every case a geographical propinquity between the successive names. The only changes needed to secure complete conformity are the reading of east for west where Schöner mentions Parias,

* A review of F. C. Wieder, edit.: Monumenta Cartographica: Reproductions of unique and rare maps, plans and views in the actual size of the originals; accompanied by cartographical monographs. Vol. I, The Hague, 1925.

[1] Henry Harrisse: The Discovery of North America, London and Paris, 1892, pp. 524–525.

[2] A. E. Nordenskiöld: Facsimile Atlas to the Early History of Cartography, Stockholm, 1889, pp. 80 and 82 and Pl. XL.

[3] Edward Heawood: The World Map Before and After Magellan's Voyage, *Geogr. Journ.*, Vol. 57, 1921, pp. 431–446; reference on p. 441.

[4] Harrisse, *op. cit.*, p. 524.

Darien, and Urabe, and the alteration of the latitude of the city of Lop from 43 degrees to 48 degrees.

Finally the name "Perisch," at the bottom of the right gore on Plate 3, seems a decisive piece of evidence. As Dr. Wieder points out, this name does not occur on any other known map. Dr. Wieder interprets it as "Per J. Sch."—that is, by Johann Schöner. The present writer is ready to accept Dr. Wieder's identification of this map as the real Schöner globe of 1523–1524.

The Behaim Conceptions

This Schöner gore map is the first of a type that was common in the second quarter of the sixteenth century. The essential features are derived from the Behaim combination of the Ptolemaic world map and the narrative of Marco Polo. This original concept was modified by nearly thirty years of discovery and exploration on the part of the Spaniards, Portuguese, and English. The evolution of the Schöner 1523 type of map may be summarized as follows. In the latter years of the fifteenth century Ptolemy's "Geography" had become the geographical Bible to the peoples of western Europe. Ptolemy had mapped the world from the Canary Islands eastward to the eastern shore of the Magnus Sinus. This known portion of the world was comprised within 180 degrees. In his extreme east Ptolemy placed Serica, the Sinarum Situs, and the emporium of Cattigara. His information was misinterpreted so that the coast of China, which should have been represented as part of the coast of eastern Asia, was falsely made to represent an eastern shore of the Indian Ocean. As a result Ptolemy implied more land east of the 180th meridian and an ocean beyond. Marco Polo's account of his travels in eastern Asia described lands and seaports on an eastern ocean apparently unknown to Ptolemy.

Contrary to the ideas of Vignaud and Rosenstein there was a plausible interpretation of Marco Polo's narrative which authorized the extensive additions of the Behaim globe to the Ptolemaic map. The fact that Ptolemy did not represent an eastern coast of Asia made it admissible for Behaim to extend that continent far to the east. Marco Polo relates his travels westward from Cambaluc for 132 days. At the end of this journey he said that he was *very near India*. In interpreting this account, allowing 20 miles a day for the average rate of travel and 50 miles for a degree of longitude near the 40th parallel, Marco Polo's journey represents a distance of 53 degrees. Behaim's globe placed Polo's Mangi and Cathay east of Ptolemy's 180th meridian and Cambaluc on the 41st parallel, approximately in longitude 233 degrees E.[5] Behaim allowed 60 degrees beyond Ptolemy's 180 degrees for the mainland of Asia and 30 degrees more to the east coast of Cipangu. Cipangu and the mainland of Asia were thus placed only 90 and 120 degrees, respectively, west of the Canary Islands. Marco Polo placed the kingdom of Prester John west of Cathay and Mangi; Marino Sanuto, Nicolo Conti, and Jordanus placed it in the interior of India Tertia, or that part of Asia beyond the Ganges River equivalent to the Serica of Ptolemy. Marco Polo also described the lands between Kenjanfu and Tibet as having an abundance of silk. These regions west of Mangi were considered by Behaim as equivalent to Ptolemy's Sinarum Situs, with which the Romans traded by sea for silks.

Effect of the Columbian Discoveries

Columbus reintroduced two old factors into this geography by using 56⅔ Italian nautical miles as the length of a degree instead of the longer degree of Ptolemy and by adopting Marinus of Tyre's longitude of 225 degrees for the east coast of the

[5] Similar geographical conceptions are represented by the Laon globe and by the map of Henricus Martellus Germanus, both probably dating from the period before the discovery of America.

Magnus Sinus. This resulted in a considerable eastward advancement of the longitudes given by Columbus' contemporaries—such as Behaim. By some process Columbus reasoned that the longitudes of eastern Asia and Cipangu respectively were about 270 and 300 degrees east, or 90 and 60 degrees west of the Canary Islands. Columbus stated that he had sailed 1100 leagues from the Canaries when he found Cuba. This was approximately where he thought the coast of eastern Asia would be found. On this basis of calculation he identified Española with Cipangu, which he had expected to find on the outward voyage at a distance of about 700 leagues from the Canaries.

The later voyages of Columbus resulted in further exploration of Cuba and in the discovery of South and Central America. At first South America was considered a great island of continental proportions; but as a result of Columbus' fourth voyage, it was apparently considered to be identical with the great southeastern peninsula of Asia represented by Behaim. This seems to be the best interpretation of the Bartholomew Columbus map of about 1506, when considered in connection with some Portuguese letters stating that St. Thomas[6] had been among the Indians of the east coast of South America. There is a legend on this Bartholomew Columbus map concerning the different longitudes of Ptolemy on the one part and Columbus on the other. In accord with this legend the map employs the longitudes of Ptolemy from the Canary Islands *east* to the Magnus Sinus. A different longitude calculation is employed for the space between the Canary Islands *west* to the same point. There are thirteen spaces marked, each space apparently having 10 degrees; but there are no figures to show their extent. This difference in the calculation of longitudes is an extremely important matter for the understanding of the explorations of the early sixteenth century, and it has not hitherto been given adequate consideration.

Waldseemüller and Cantino and Canerio Maps

There are two other types of maps that have introduced many errors into the interpretation of Columbian geography. These maps are derived from the Waldseemüller map of 1507 and from the Cantino and Canerio maps of about 1502. The Waldseemüller map represents the Behaim conception of the earth as far as longitude 270° E. and terminates in the east with an open sea. On the left side of the map the Spanish discoveries are represented as a long narrow strip of land extending from about latitude 50° N. to latitude 40° S. The western side of the land is named in the south "Terra Ultra Incognita" and in the north "Terra Ulteri Incognita." There is a conjectural sea to the west of the land. The difference in longitude between the eastern coast of Asia on the Behaim globe and the Columbian mainland of "Florida" on the Waldseemüller map is 55 degrees. On other maps of the type the difference is only 45 degrees. This type of map *apparently* makes the Americas a distinct continent by representing Asia as complete and by neither indicating nor implying that it has any connection with America. Schöner's globe of 1520 belongs to this Waldseemüller type. Every other type of map made before 1550 actually makes or implies a connection between America and Asia.

The Cantino-Canerio type of map discards Ptolemy's outline of eastern Asia and likewise represents considerably less than the full circumference of the earth. On the right, or eastern, margin the map terminates just east of the Malacca peninsula. However, the coast line does not round off to the north and west to complete the Asiatic continent but bends sharply into the edge of the map as if there were more land to the east. On the left, or western and Spanish, side the map is cut off immediately west of a peninsula that resembles Florida. The names on this land definitely prove it to be Cuba, identified by Columbus as a part of Asia. Other maps of the type contain in connection with this peninsula the legend, "Terra

[6] Bartholomew de Las Casas: Historia de las Indias (5 vols., Madrid, 1875–76), Vol. 2, p. 465.

de Cuba Asie Partis." Furthermore, another legend in the region of the Corte-Real discoveries definitely calls the land a part of Asia. From this it is evident that the Portuguese map makers did not question the Asiatic character of the Columbian discoveries at the time when these maps were made.

Relation Between Asia and America

From the above it becomes apparent that the present accepted view, namely that it was early understood that America was distinct from Asia, needs revision. A new hypothesis is required, one that neither (1) envisages two separate and distinct continents, since such continents are not represented on any other type of maps, (2) nor admits of two east coasts of Asia, (3) nor removes from the map Behaim's enormous eastern Asia prior to any exploration of the region in which it was placed, (4) nor leaves unaccounted for otherwise the important island of Cipangu. Such an hypothesis, suggested by the legend concerning longitudes found on the Bartholomew Columbus map, may be stated as follows: the various map types represent, each in its own way exactly the same general conception of world geography.

This conception was that of the world as shown on the Behaim globe, the persistence of which is evident to anyone who will assemble the maps remaining to us from the early sixteenth century. *Apparent* differences between the several types of map were due to differences in conception regarding the length of a degree. The Waldseemüller maps solved the problem by merely duplicating the eastern coast of Asia. On the right side Asia was represented with the Ptolemy-Behaim longitudes; on the left it was given with Columbian longitudes. Two theories were thus presented on one map, and you could take your choice between them. This was a very plausible way of presenting a problem at the time insoluble.

The Cantino-Canerio maps do not deny the Ptolemy-Behaim geography. They imply it but avoid the longitude question by leaving off all indication of longitude. To admit that these maps discard Behaim's eastern Asia would be to violate what we may here state as an axiom, "Any feature once placed on a map tends to remain until complete exploration leaves no room for it." According to my hypothesis, therefore, the Spanish lands represented on the left side of the Cantino and Canerio maps are no other than Behaim's extreme east of Asia, and the Island of Cipangu is represented by Española, with which it was identified by Columbus and upon the Johan Ruysch map. The Waldseemüller type on the other hand *duplicates* both eastern Asia and Cipangu. This view of the Asiatic connection of the Spanish discoveries would appear to be further confirmed by the Portuguese letters about St. Thomas having been among the Indians on the eastern coast of South America, by the names on "Florida" and the legend about Asia on the Cantino and Canerio maps, and by the three Reinel charts of the East Indies,—the first and second of which show an eastern coast of the Magnus Sinus. The Magnus Sinus itself is named on some of the maps as the Mar del Sur. On the Wieder-Schöner it is the Mar de Sur. Moreover, it is known that Balboa expected to find the Spice Islands not far west of the Isthmus of Panama. Cortes also looked for the Spice Islands off the coast of Mexico.

The Schöner Map

This brings us to the Schöner map of 1523–1524. Magellan's voyage of 1519–1521 is said to have proved that South America, by some regarded as an island (witness the Lenox globe and the Schöner globe of 1520), was a part of Asia. No one, of course, could reach this conclusion except theoretically and on the basis of a particular hypothesis. All of the known world maps dating back to the period between 1492 and 1520 either actually represent, imply, or, at least, do not deny the existence of the eastern Asia of Behaim. Some of them, as the Waldseemüller

map of 1507, represent two eastern Asias and either two peninsulas from southeastern Asia or one peninsula and one great island. One peninsula at least was assumed as indisputable. The Spaniards had quite definitely proved by 1523 that South America was connected with the northern continent. Magellan showed by his voyage that only one great peninsula besides Africa extends into the southern hemisphere. Therefore, under the assumption mentioned, South America was demonstrated to be a part of Asia and, *ipso facto*, to be the Behaim peninsula of southeastern Asia. It is particularly significant that Schöner should have said that his two globes agree with each other—unless we are to believe that the Spanish lands, represented as separated from Asia on the 1520 globe, were somehow regarded as a duplication of eastern Asia.

After 1523, with few exceptions, the maps belong either, on the one hand, to the type of the Ribero school, having unexplored coasts omitted but not denying the Asiatic connection of America, or, on the other hand, to the general type of the Wieder-Schöner map. In both types the duplication of eastern Asia ceases and the Behaim peninsula disappears—unless the South American continent is intended for it. The Mar del Sur is identical with a greatly enlarged Magnus Sinus. The town of Cattigara was repeatedly placed on the west coast of South America, and this may have had some influence in leading Pizarro to Peru.

The Wieder-Schöner gore map, if genuine, is the oldest map remaining to us, except the Bartholomew Columbus map, that definitely and simply represents the world according to the later Columbian conception of the configuration of the land. It was able to do this more clearly than any predecessor because Magellan's voyage made it impossible for anybody plausibly to contend for Columbus' short degree. The elimination of the Columbian degree permitted a reasonable harmony of opinion on the subject of longitudes. As a result, for a considerable period of years, the Schöner map of 1523 became the prevailing type. The one important exception is a group of French maps resulting from the Verrazano discoveries. The next important change in the cartographical outline of America-Asia was due to the introduction of the Strait of Anian, and that was based on the fact that the American continents nowhere contained the fauna of Asia.

Dr. Wieder's Work

Dr. Wieder's work gives promise of being a really noteworthy contribution to historical geography. In addition to the gores described above, the present volume contains "Central Europe by N. B. 1553" (Natalis Bonifacius); "The Straits of Magellan by Thomas Cavendish, 1588"; "C(ornelis) D(oetsz) Navigation chart to the North and the Baltic, 1610 issue of the unknown original edition of 1589"; "The Philippines Islands, c. 1660"; together with 18 plates and plans of cities and ports taken from the manuscript atlas of Johannes Vingboons dating about 1660. The notes and bibliographical references add markedly to the value of the work.

There is only one serious objection to the plan of the first volume. While the views and plans of cities are certainly not without interest to the geographer, one cannot but regret that this material of relatively lesser interest has been included while there remain unreproduced and very difficult of access many map treasures of greater and more general importance. It is to be hoped that the future volumes will be devoted to maps alone until all of the rare old maps of the libraries of Germany and Holland have been made readily available. A contemporary work, "Tabulae Geographicae Vetustiores in Italia Adservatae," by G. Curaci, proposes to reproduce the rare maps now contained in the libraries of Italy.[7] Would that capable cartographical authorities might soon attempt a similar task for England, France, and Spain.

[7] Reviewed in the *Geogr. Rev.*, Vol. 17, 1927, pp. 174–175.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of March and April. At the regular monthly meeting of the Society on March 22, President John H. Finley presiding, Sir Curtis Lampson described his journey across the French Sudan to Timbuktu. From many remote districts he was able to gather an excellent photographic record and valuable notes on Tuareg customs, native industries, and desert and oasis scenery.

At the regular monthly meeting of the Society on April 26, President John H. Finley presiding, Dr. Samuel K. Lothrop of the Museum of the American Indian delivered a lecture entitled "Aboriginal American Culture and the Geographical Environment." He described the cultural similarities and differences of aboriginal groups in North and South America, illustrating his address with photographs of some of the best specimens in the Museum. In addition he outlined the results of original field work upon the sites of some of the newest and most interesting archeological discoveries of recent years.

Before the lecture President Finley read Council resolutions on the death of Dr. Walter B. James and Mr. Edwin Swift Balch. He commented on their long association with the governing body of the Society and their part in forwarding its research work. The resolutions are printed below.

Elections to Fellowship. At the March and April meetings of the Society, President Finley presiding, there were presented with the approval of the Council the names of 41 candidates, who were duly elected as Fellows of the Society.

Resolution on the Death of Dr. Walter B. James. Dr. James died at his home in New York on April 6. The following resolution was passed by the Council at its monthly meeting of April 17 and entered upon the permanent records:

"By the death of Dr. Walter B. James on April 6 the Society has lost an old and valued friend. It is fitting that the Council should record its appreciation of his services and character. He became a Fellow of the Society on March 10, 1890, and, joining the Council on March 17, 1910, continued with the administration until his death. He was Vice President of the Society from February 16, 1911, until December, 1914, when he resigned. He served on many important committees and was active and most helpful in affairs both by his labor and advice. His wide experience, his clarity of judgment, and his scholarly attainments rendered him a most capable associate, and he gave freely of his time and effort notwithstanding widespread demands upon him of public and civic service. His courtesy and consideration for the feelings of others endeared him to his associates and create a sense of personal sorrow in the void left by his departure. We tender to his family our respectful sympathy in their bereavement."

Dr. James had two faculties which were especially appreciated by his associates at the American Geographical Society: he liked to give time and thought to the work of the institution, and he had the gift of hospitality. He was interested in research, for its purposes and needs were clear to him from his experience as an investigator in medical science. The Millionth Map of Hispanic America had his special support and interest, and he watched its progress as closely as he did that of the other publications of the Society. At his hospitable fireside the publication committee, of which he was for many years the chairman, held its annual meeting. Encouragement and practical help were always given in full measure under his wise and tolerant leadership.

Resolution on the Death of Mr. Edwin Swift Balch. Mr. Balch died at his home in Philadelphia on March 15. The following resolution was passed by the Council at its monthly meeting of April 17 and entered upon the permanent records.

"RESOLVED that the Council of the Society express to the family of their late associate, Edwin Swift Balch, their deepest sympathy. Mr. Balch was elected a Life Fellow on November 13, 1900, and he was elected to the Council of the Society on November 21, 1912. He was often consulted on geographical questions, upon which he gave able advice; he published important papers on geographical questions in the journal of the Society; he was active on committees of the Council and attended the meetings of the Council with regularity; and he was in active correspondence with the administrative officers regarding the policy and activities of the Society. He could always be counted upon for the support and encouragement of the Society's work and followed all of its proceedings with the deepest interest."

Mr. Balch's interest lay primarily in exploratory fields, especially mountaineering and polar exploration, his views thereon being expounded in a series of books. He also sought to make geographical application of his studies of the fine arts, publishing several volumes on the distribution of art and its bearing on comparative ethnology. He contributed numerous papers to scientific periodicals: those to the *Bulletin of the American Geographical Society* including: "Stonington Antarctic Explorers" (Vol. 41, 1909), "Heart of the Antarctic" (Vol. 42, 1910), "Charcot's Antarctic Explorations" (Vol. 43, 1911), "Palmer Land" (Vol. 43, 1911), and "Antarctic Names" (Vol. 37, 1905, and Vol. 44, 1912). His last contribution to the Society's journal, "The First Sighting of West Antarctica" (*Geogr. Rev.*, October, 1925, was in continuation of his efforts to promote a knowledge of the important share that Americans, notably Wilkes and Palmer, have had in the exploration of the Antarctic.

Elections to Membership in the Council. At the March meeting of the Council of the Society on April 17, Mr. Oliver B. James and Mr. Frederick Hellmann were elected Councilors of the Class of 1930.

Donations to the photographic collections. Through the kindness and generosity of Mr. Henry J. Thayer the Society has received from time to time a large collection of panoramic photographs from Central and South America, including the gift in May last of 54 views taken in Peru, Chile, Argentina, Uruguay, Brazil, and the Panama Canal. Grateful acknowledgment is hereby made of these valuable contributions to the Society's collections.

GEOGRAPHICAL RECORD

NORTH AMERICA

The Port of New York. In the *Geographical Review* for October, 1925 (Vol. 15, pp. 654–655) announcement was made of the publication by the Corps of Engineers of the U. S. Army and the U. S. Shipping Board of the first five numbers of a series of documents relating to American ports. Since then twelve more numbers of this important "Port Series" have appeared, one of which, No. 20, deals with New York. This number is divided into three parts: Part 1, a general report; Part 2, statistical data relative to piers, wharves, and docks; and Part 3, an atlas of large scale maps showing the various port facilities.

Disregarding the broader relations of New York, let us consider briefly a few significant facts about this great port, which itself constitutes a geographical region of no small area and of enormous complexity. The area included under the jurisdiction of the Port of New York Authority, "an organization formed by compact between the States of New York and New Jersey" and ratified by the U. S. Government in 1921, includes not only the city of New York, but the southern half of Westchester County in New York State, as well as "nearly five whole counties in New Jersey." The population of this area in 1920 was 7,750,000.

Two mighty factors contributing to the growth of New York are the size and the intricate configuration of the body of water which comprises New York harbor and its connecting bays and rivers. These provide not only a vast stretch of sheltered water for anchorage but also an immense water frontage. At the present time no less than forty-nine anchorage grounds are reserved by the administration of the port. A high degree of specialization has been developed in the apportionment of these anchorages. For instance, anchorage No. 7 in the East River is "used mainly by sail vessels and barges, eastbound," No. 15, also in the East River is "largely used by steam yachts." No. 19 on the east side of the Hudson River is reserved for ships of the U. S. Navy; other anchorages are set aside exclusively for steamships, for barges, for sailing vessels, for the temporary use of "large ships waiting for a berth, occupancy not to exceed 72 hours . . . ," and six anchorages are reserved for vessels carrying explosives.

The port of New York has a direct water frontage of 771 miles. "The developed frontage measured around piers and the heads of slips is 346.5 miles." There is thus ample room for further expansion. The local topography, however, creates certain very serious drawbacks. These arise primarily out of the fact that the greater part of the immense population of the port of New York, together with its principal transshipment areas, are on islands separated from the mainland to the west by bodies of water a mile and more wide. The majority of ocean vessels find their berths on the side of the harbor opposite the freight terminals of all but one of the railroads leading to the interior of the country. As a consequence, not only does most of the traffic between the markets and manufactories of Greater New York City and the interior have to be shipped across the water to the New Jersey side, but, in addition, the bulk of the imports and exports that pass through the port. The reasons for this will be found in the historical development of New York, which "as a port antedates railroads. The city knew ships and barges from the beginning of its history, and had taken the outline of its present shape before rail transportation on the modern scale was thought of. Herein it differs from younger ports, as on the Gulf and Pacific coasts, which were shaped by railroads or by the local authorities from the start."

Owing to this topographical peculiarity, the visitor to the port of New York sees innumerable barges and freight-car floats plying back and forth between Manhattan, Brooklyn, and the New Jersey shore. Of a stretch of 13.9 miles of waterfront on the New Jersey side of the Hudson, no less than 7.27 miles are controlled by railroads. "On Manhattan, from the foot of West Seventy-second Street around the Battery to the foot of East Twenty-second Street, a distance of 10.67 miles, 2.55 miles are occupied by railroad lighterage piers, float bridges, and pier stations." Although the costs of the transshipments thus effected are immense, the economies achieved in other ways through the use of New York as a shipping port so far outbalance them that there seems little chance of New York ever losing its supreme position among the ports of America.

A Fossil River in Kansas. A striking and well illustrated account of a fossil river channel in western Kansas is given by W. W. Rubey and N. W. Bass in Bulletin 10 (1925) of the State Geological Survey (The Geology of Russell County, Kansas, with Special Reference to Oil and Gas Resources, pp. 7–86). The rolling surface of the county, worn to moderate or low relief on a series of nearly horizontal sandstones and shales with occasional badland patches along the sides of its larger valleys, is interrupted here and there on its gentle slopes by ragged outcrops or "hoodoos" of cross-bedded sandstones, vivid reddish in color alternating with white, gray, buff, and brown, which appear to be the exposed parts of the channel deposits, elsewhere eroded or buried, of an ancient river that flowed westward, as indicated by the prevailing slant of the cross-bedding, at the time when the associated finer-grained and more evenly bedded strata were laid down probably as flood-plain deposits. The hoodoos are frequently enough exhibited along a serpentine course on the broadly dissected plains to make it probable that, as shown on an outline map, their sandstones are the deposits of a single and continuous meandering stream of good size, with one or two tributaries.

W. M. DAVIS

Meteorological Conditions along the Chicago-Fort Worth Airway. The rapid development of regular flying routes and the importance of meteorology in relation to flight are both strikingly emphasized in W. R. Gregg's "Meteorological Conditions Along Airways" (*Natl. Advisory Committee for Aeronautics Rept. No. 245*, Washington, 1926).

What aviators need is information concerning the principal meteorological elements as determined by records extending over as many years as possible, and also the current data and forecasts for each airway. Decisions regarding the locations of landing fields, the orientation of airdromes, the adoption of flight schedules, and many other similar matters, require as full and as accurate a knowledge of meteorological conditions and phenomena as can be made available. Such conditions as local wind gustiness due to topography; fogs; the probability of heavy rains or snows or ice storms, and visibility, must be known in advance if the best arrangements for flying routes are to be made. The characteristics of the winds at different levels; the frequency of low clouds; the number and intensity of thunderstorms; the frequency of excessive precipitation, are other conditions of vital importance.

The meteorological conditions along the Chicago-Fort Worth Airway are discussed as an example of what is known and can at once be made available for practical everyday use on the part of aviators. The vital factor of the wind at different elevations is discussed as fully as the available data permit. Several interesting points are brought out. For example, the frequency of very low visibilities is not a serious factor along the route; dense fog is of infrequent occurrence; snow is a serious problem only over the northern third of the route; night thunderstorms are often severe; during hot weather flying takes place at comfortable temperatures at a

moderate altitude, and when it is excessively cold at the surface there is but little decrease of temperature with elevation—in fact, it is often warmer aloft; there is a distinct preponderance of westerly and northwesterly winds at the higher levels, especially over the northern part of the airway.

R. DEC. WARD

The Climates of California. By reason of its great latitudinal extent, and its marked topographic features, California necessarily includes a wide range of climates and has therefore always been of peculiar interest to climatologists and geographers. There are available the rather meager official discussions of California's climates in the regular Weather Bureau publications. There is McAdie's "Climatology of California." There are several special reports on the rainfall by McAdie, W. G. Reed, and others. There has also been a brief discussion of the climatic provinces of the state by Reed in his paper on the climatic provinces of the western United States (*Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, pp. 1–19).

In a recent monograph, "Climates of California," by R. J. Russell (*Univ. of California Publs. in Geogr.*, Vol. 2, 1926, pp. 73–84), Köppen's well-known classification of climates is followed in the main, but certain modifications based on local climatological data have been adopted. A few minor changes have been made in the critical values suggested by Köppen, and four new sub-types of climate have been introduced. The distinction between dry (B) and humid (C and D) climates is naturally of special significance in California. With the California maximum of rainfall, the boundary between these two is marked by the isohyetal line of 14 inches when the mean annual temperature approximates 55° F. When, with higher temperature, evaporation increases, there is need of more rainfall. At a mean annual temperature of 70° F., for example, the isohyetal line of approximately 17 inches becomes the boundary. A similar general relationship obtains between the desert and the steppe areas. At a mean annual temperature of 70° F., "desert" areas may have as much as 13 inches of rainfall. Russell finds that a cold-month isotherm is just as applicable as a climatic boundary in dry as in humid climates and has modified Köppen's scheme in that respect, Köppen having used cold-month isotherms as boundaries in the humid areas and mean annual isotherms in dry areas. For example, the January isotherm of 32° F. is used to separate the dry cold from the dry hot. A minor subdivision of the "hot desert" is introduced in order that the Mohave and the Colorado types may be differentiated—a distinction demanded on biological grounds. The author also points out that "double-roofed houses, arcaded sidewalks, and other cultural evidences of hot weather are more common in the Colorado than in the Mohave." The line which separates areas having three months or more of mean maximum temperatures above 100° F. from those below those limits is a satisfactory criterion in the desert areas. The west coast foggy desert of the southernmost coast will probably later need subdivision, in the light of newer data. Köppen's "hot summer" and "cool summer" Mediterranean types are found to fit California conditions very well. The former is typified by the Sacramento Valley; the latter, by the Coast Range region of Central California. A new province embracing the well-known "fog belt," with the Redwoods and California Laurel, is added to Köppen's scheme, as is a province whose lower boundary is marked by the isohyet of .75 inch for the three consecutive driest months, and which includes the yellow pine—Douglas fir forest. There are also certain other modifications for the details of which the reader should consult the original paper. The tundra climate, with monthly means below 50° F., is found in a narrow strip in the High Sierra and on the summit of Mt. Shasta.

An excellent colored map shows the various climatic provinces. This is on a sufficiently large scale to be useful in any local studies of California climates. The report is a noteworthy illustration of the fundamental soundness and usefulness

of Köppen's original map and of desirable modifications of that scheme for detailed local study.

R. DEC. WARD

The Indians of Southeastern Panama. Southeastern Panama, the scene of the first Spanish exploration and settlement on continental America, "ethnologically has remained practically unknown." The scant available data are discussed by

FIG. 1—Map of Panama east of the Canal Zone, showing the distribution of the main racial types. The white areas are supposedly without permanent inhabitants. Based on Figure 1 of Mr. H. W. Krieger's report. The original shows tribal subdivisions among the Cuna. Scale 1 : 3,000,000.

Mr. H. W. Krieger in a recent publication of the Smithsonian Institution (Material Culture of the People of Southeastern Panama, Based on Specimens in the United States National Museum, *U. S. Natl. Museum Bull. 134*, Washington, 1926). The Indian population belongs to two major stocks, Chocó and Cuna. The Chocó live on the Pacific slope of the major divide formed by the Cordillera de San Blas and the Serrania del Darien. The Cuna occupy the upper Chucunaque basin, the central highlands, and the Caribbean coast, the Cuna of the last-named region forming a distinct tribal group—the Tule (Towali), or San Blas, Indians. From certain sections of the country, notably adjacent to the Canal Zone and in the Tuira valley, the Indian has been forced out by a population mainly negroid, but there remain large areas without permanent inhabitants so far as is known. It is reported that

the interior formerly was more extensively and permanently occupied. The middle Chucunaque River now is intermittently traversed by roving bands of mountain Cuna. The swampy and unhealthful area along the Pacific coast is uninhabited, with the exception of some negroid settlements.

Chocó and Cuna exhibit physical and cultural dissimilarities. On the basis of measurements made by Mr. R. O. Marsh's expedition of 1924, Dr. Hrdlička describes the Chocó as being nearer the Nahua type, while the coastal Cuna are related to the Maya on one hand and the Yungas of the Peruvian coast on the other (Aleš Hrdlička: The Indians of Panama, *Amer. Journ. of Phys. Anthropol.*, Vol. 9, 1926, pp. 1–15). A striking difference between the two peoples is seen in their relation with outsiders. The Chocó are trusting and hospitable (cf. Thomas Barbour and W. S. Brooks: The Sapo Mountains and the Sambú Valley, *Geogr. Rev.*, Vol. 13, 1923, pp. 211–222). The Tule, hostile to foreigners, have preserved their tribal isolation in a remarkable way. Culturally, as exemplified in their houses and boats and in their social organization, the Tule are superior. They live in villages on the small islands that fringe the hundred-mile stretch of the San Blas coast. Their plantations are on the mainland, where the men also go to hunt game. Their numbers are estimated by the Intendente of San Blas as between 20,000 and 25,000. In a list of villages compiled by Mr. Marsh the population is given at a little over 24,000. By gaining the confidence of the San Blas Indians his expedition had exceptional opportunities for study. One result of it was to give prominence to the "white Indians" of the region. General scientific opinion, as expressed in the report of Mr. R. G. Harris (The San Blas Indians, *Amer. Journ. of Phys. Anthropol.*, Vol. 9, 1926, pp. 17–63) is that the white Indians represent a form of albinism, a condition that appears to be not infrequent among tropical Indian tribes. The percentage of albinism among the Tule is, however, exceedingly high, 0.7 per cent, and is to be attributed to intense inbreeding in their jealously maintained isolation.

SOUTH AMERICA

Irrigation Projects in Peru. The irrigation canal is a part of the traditional equipment of the Peruvian farmer. Of the 4,000,000 acres estimated to be under cultivation at present in the Cordillera and the coastal valleys of the republic the greater part is irrigated. In the coastal valleys, where 640,000 acres now under cultivation produce nearly half of the agricultural produce of the country, the farmer must depend entirely upon the irrigation canal for his water supply.

There is much evidence of extensive irrigation systems in pre-Inca times. Certainly the strength of the Incas was due in no small degree to the fact that they had insured the well-being of the agricultural population of the empire by organizing them into communities and providing them with highly efficient systems of irrigation and a well-considered plan of land tenure, water rights, and crop rotation. When the Spanish divided the farm lands of the conquered Inca Empire into great estates they destroyed many of the Indian farm communities. Those which they retained in order that they might have an established agricultural population upon which they could draw for labor were kept in quite as complete a state of subservience as they had known under Inca rule with none of its compensating benefices. In the coastal valleys such of the farm communities as were not destroyed were permitted to retain a semblance of their traditional rights to land and water. But the formation of large estates greatly diminished the amount of land available for small holdings; and, except in those places where the water rights of the Indian were protected by the Church, only the surplus water that was left after the full requirements of the estates had been filled was released to them. Moreover, without the regulations for the upkeep of the irrigation canals which the Incas rigorously enforced, much of the old irrigation systems fell gradually into disuse. Under the first seventy-five years

of the republic little was attempted and nothing accomplished to improve conditions. Today many of the large estates have no longer sufficient water to keep more than a half or a third of their land under cultivation, and a large part of the land still under cultivation has water only in the flood season. The condition of the small land owners is even worse.

President Leguia at the beginning of his first administration in 1908 recognized the deplorable state into which the rural Indians had fallen as the chief obstacle in the way of social progress in his country. To provide for the economic independence of a farm population which was increasing at an estimated rate of 28,000 a year the large estates might have been divided into small holdings as has been advocated by many economists in recent years and actually put into practice in Mexico and some of the newly-formed republics of Europe. Such a course would neither have been politic nor have added to the total of cultivable land in the republic. The President chose the alternative plan of attempting to provide new lands for colonization by improving and increasing the irrigation systems of the coastal valleys.

In 1904, under President Pardo, the government had already begun an inventory of the land and water resources of the coastal valleys. President Leguia took up this task, and in 1920 a tentative plan was drawn up which would bring under cultivation a million acres of new land scattered over twenty valleys. In June of that year work was begun on a scheme for the irrigation and colonization of about 20,000 acres in the Pampas Imperial in the Cañete valley 80 kilometers south of Lima. The project was carried out under the direction of an American engineer, Mr. Charles W. Sutton, who is in charge of the government's irrigation work and who must share with President Leguia the honor of giving to Peru the new era of prosperity which now seems assured to her. In 1923 the work was completed, and in 1924 the land was offered for sale in lots of 12½ acres or more at approximately $110 per acre. The entire area was sold in 24 hours to men from every social class. In less than two years after the sale of the land 60 per cent of it was under cultivation and was producing an annual crop equal in value to more than half of the total capital invested.

The wisdom of the plan being thus confirmed, work was immediately begun on the second major project in the government's agenda—the irrigation of the arable land in the Department of Lambayeque. (For reports by Mr. Sutton and articles on the project by F. P. Farrar see various issues during 1924, 1925, and 1926 of the *West Coast Leader*, a weekly magazine published at Lima.) The Department of Lambayeque has been chosen as the site of the second important project because it is said to offer a greater area of good soil capable of irrigation than any other department of the republic. It is estimated that there are 750,000 acres of superior soil in this department which can be irrigated. The department is watered by five rivers, which are intermittent throughout a large part of their channels and which, under the present system of irrigation, provide a full perennial supply of water to only about 62,000 acres. An additional 125,000 acres under cultivation are supplied with water only during the flood season. It is planned to supply full irrigation to these 187,000 acres now under cultivation and to add to them 168,000 acres more, making a total of 355,000 acres under full irrigation when the project is completed.

The plan calls for the consolidation of the flow of the five rivers that water the department; the construction of storage reservoirs and drainage canals to regulate their flow and provide against destructive floods like that of 1925; and the construction of diversion canals and eighteen miles of tunnels, one of which will be ten miles in length, through the main cordillera of the Andes by which the flow of the Huancabamba River, a tributary of the Marañon, will be brought into the channel of the Olmos River on the Pacific side of the divide. By means of tunnels and canals the flow of these six rivers will be united in a single system with their natural fluctuations balanced by a storage reservoir on the Huancabamba River and a storage reservoir and diversion canals on the Chancay River. On the Chancay River storage will be

provided by a dam fifty meters high to be constructed at Carhuaquero. It will permit the maintenance of a full supply of water throughout the year on the sugar lands of the Chancay delta, permit lands on the northern edge of the delta to receive

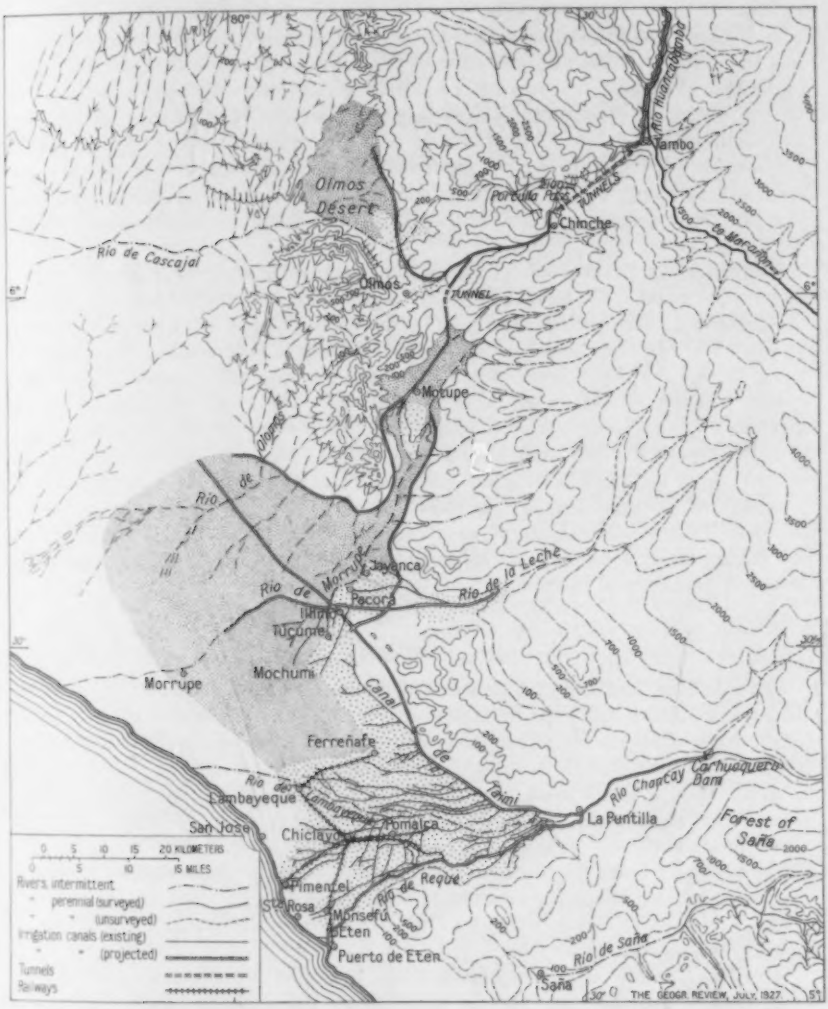


FIG. 1—The Lambayeque Irrigation Project. Based on compilation prepared for the Piura sheet of the American Geographical Society's Millionth Map of Hispanic America from original surveys made by the Irrigation Commission and the Jayanca sheet of the Carta Nacional of Peru. Elevations are in meters. Where the proposed canals follow river beds or existing canals only the symbol for the canal is given. Approximate areas now under perennial or summer irrigation shown by open stipple: approximate extent of new lands to be brought under irrigation shown by close stipple. The entire stippled area will have full perennial irrigation when the project is completed. Scale 1: 1,500,000.

the benefits of the early floods of the Chancay River, and diminish the damage now caused by excessive floods from the Chancay watershed. It is of immediate necessity and will be the first item in the project to be completed. The second storage reservoir, which will also be provided by a 50-meter dam on the Huancabamba River on

the Atlantic side of the main cordillera, will be for the sole purpose of maintaining a full supply of 700 cubic feet of water per second to the Huancabamba diversion canal.

It is estimated that the cost of the completed project will be $20,000,000. The irrigation works alone embrace six major diversion tunnels, 150 miles of trunk canals, 18 miles of tunnels, and 100 miles of trunk outlets. In addition it will be necessary to build some 300 miles of roads capable of carrying heavy motor traffic. Labor has had to be recruited from distant parts of the republic, camps built, and food supply organized. The sanitation and water supply of fifteen towns will have to be provided. On account of the disastrous floods of 1925, which destroyed much incompleted work and which required the efforts of a large part of the personnel of the government's Department of Irrigation in restoring irrigation work in other parts of the coast, the scheme is now only about 20 per cent finished. All of the preparatory work, however, has been completed (see Charles W. Sutton's letter in the *West Coast Leader*, March 22, 1927).

Meanwhile the government's irrigation engineers have also been engaged in other parts of the coast. The work, now under way, of restoring the irrigation systems of the Piura and Chira valleys destroyed by the floods of 1925 will ultimately irrigate 95,000 acres. In the Pampa of Chilca and the Pampas of Huambo two projects are being carried out, by private capital but with government assistance, which will irrigate 10,000 acres and 17,500 acres, respectively. In the past six years the government has supplied full irrigation to 40,000 acres. It is expected that the work can now be carried on at the rate of at least 40,000 acres a year and that in 1931 a total of 160,000 acres will have been given full irrigation, while summer irrigation will be provided for an additional 80,000 acres. The fact that at present the exports of cotton and sugar from 640,000 acres of land under cultivation in the coastal valleys of Peru are about equal in value to the exports of copper, silver, and petroleum is a sufficient guarantee of the practicability of the project.

EUROPE

The Populous Lowland of Valencia. The crescent-shaped Valencian lowland on the eastern coast of Spain has an area of only 2000 square kilometers, yet it supports by the fruits of its soil more than 500,000 people. Such an agglomeration of human beings is common enough in an industrial region, but it is a phenomenon worthy of study when it exists solely through an agricultural relationship to the environment. The explanation of this dense human group is given by Johann Sölch in "Die Landschaft von Valencia" (*Geogr. Zeitschr.*, Vol. 32, 1926, pp. 337–359). Professor Sölch finds it in the sequence: mountains-snowfields-streams-alluvium-irrigation, without which the area would be a real desert.

The Valencian area as a whole may be divided into four geographic sub-regions from the human-use standpoint:

(1) Coastal zone—unhealthful and scantily peopled by fishermen and sailors.

(2) Campo regadio—the huertas and vegas—the area of intensive irrigated cultivation and dense population.

(3) Campo secano—the unirrigated agricultural zone of moderate population.

(4) Highland border (600–1000m. elevation)—the zone of sparse population which exists chiefly by rearing sheep and cultivating cereals.

The summers in Valencia are so dry that the natural vegetation is a grass steppe, salt steppe, heath, or sclerophyllous woodland. Rains begin torrentially in September or October, causing violent and destructive floods. During the winter precipitation diminishes to where it barely suffices for the winter crops; but the snow which falls on the mountains to the west is an accumulated wealth for the following summer. A second maximum in rainfall comes in spring; and this is the most important factor in the economy of the province, for it supplies irrigation water in the

early summer. North-northeast winds during winter often cause ruinous frosts, and in spring the temperatures may fall below freezing because of rapid nocturnal radiation under cloudless skies. Hot, dry summer winds bring Saharan conditions, frequently so insufferable that the natives cover the streets with awnings. The rainfall averages under 500 millimeters and occasionally falls to 350 millimeters or even less. Sometimes one-fourth of the entire rainfall occurs in a single day, thus aggravating the drought through the rest of the year.

The lowland of Valencia is a young alluvial plain filling an old bay between two prongs of the mountains which here extend to the edge of the sea. The plain has been formed through the coalescence of the deltas of the Jucar and other streams, which have cut deep gorges in their upper reaches and brought down vast quantities of rich sediment from the encircling limestone mountains. The sands, marls, wine-red clays, and black silts thus formed are in the main fertile.

Romans, Moors, and the modern Spaniards have done wonders with water and soil in Valencia. Here, as early as 1239, severe laws were worked out to govern the use and conservation of water. Today the stringent water laws of Valencia contrast strikingly with the milder laws in force in the better-watered parts of Spain. Professor Sölch gives an exceedingly good description of these laws as expressions of social viewpoint and social organization in relation to a semiarid environment.

By the careful use of stream and ground water there has been created in the Valencian lowland one of the most luxuriant landscapes in the entire world. In addition, the county of Valencia applies to its soils more than 16 per cent of all the commercial fertilizer used in Spain. Land has been subdivided until the average family is supported on half a hectare of land. Valencia produces 80 per cent of the Spanish rice crop; and this, supplemented by vegetables, feeds her laboring classes. Fancy wine grapes, strawberries for the Madrid market, and winter vegetables for northern Europe are produced in great quantities. One hectare of land often carries 250–265 orange trees (yielding 50 pounds a tree annually), corn grows to a height of five or six meters, wheat gives astonishing yields, clover is cut nine or ten times a year, mulberry trees furnish three cuttings annually, and fancy vegetables grow to huge size. So important is water to this high-pressure system of production that it is proverbial throughout Spain that both the men and the fruits of Valencia are soft: "La carne es yerba, la yerba agua; los hombres mujeres, los mujeres nada."

A brief but effective picture of the dominance of irrigation in the life of the Valencian lowland has also been given recently by J. F. Unstead in a paper "Geographical Regions Illustrated by Reference to the Iberian Peninsula" (*Scottish Geogr. Mag.*, Vol. 42, 1926, pp. 159–170).

G. T. RENNER

The Distribution of Population in Galicia, Spain. "Distribución geográfica de la población en Galicia," by J. Dantín Cereceda (Junta para ampliación de estudios e investigaciones científicas, Centro de Estudios Históricos, Madrid, 1925) is the first of a series of regional population studies which when completed will provide a detailed population map for the whole of Spain. The present contribution is described by its author as having only "un mero valor documental." It comprises a colored map on the scale 1: 800,000 and a brief explanation of method and results. Señor Cereceda's work on the natural regions of his country is well known, and he promises a geographical interpretation to accompany further studies.

Statistics were furnished by the Census of 1920 and the "Nomenclátor de las ciudades, villas, lugares, aldeas y demás entidades de población de Espana" (1924). On the map population is shown by equal-density curves. Fifteen grades are used—from under 20 to over 300 people per square kilometer (52 to 777 per square mile). Towns of over 2000 are abstracted.

The population density of this northwestern region of Spain, 188 per square mile on an area somewhat less than Massachusetts and Connecticut together, is well

above the average for the country (111). It is essentially rural. Eighty per cent live in towns and villages, but these are small: of the 25,098 unit groupings, 95 per cent have under 200 people. The figures are interesting: 13,188 have less than 50 inhabitants; 7393 have 50–100; 3355 have 100–200. Only 31 places have over 2000 people, and several of these cannot be properly described as urban. Only 7 of the 31 towns have over 10,000 people. Coruña has over 50,000. As one would expect, the areas of densest population are on the coasts where the fishing industry flourishes and finds excellent harbors in the rias. Densities here are far from uniform, however. A notably sharp gradient occurs east of Finisterre where conditions are not so favorable, and the locality (Jallás) stands out as a distinct enclave amid characteristic coast populations. Save for the fertile Miño valley in Orense the interior populations are much less dense, the lowest figure being attained in the mountainous southeast.

Place Names and Plant Geography Illustrated from the Vicinity of Munich. Place names have something in common with fossils. Extraordinarily enduring, they tend to persist after profound changes have taken place in the language, race, and nationality of the people who use them and even in the very features of the landscape to which the names were first applied. In countries that have been occupied by man for a long time, the place names may serve the historian much as fossils serve the geologist or artifacts the archeologist—by giving a clue to conditions that prevailed in the past and for which little or no other evidence is available.

One of a variety of ways in which the geographer may profit by the study of place names is illustrated by Wilhelm Troll in an article entitled "Die Bedeutung der Ortsnamen für die pflanzengeographische Forschung" (*Zeitschr. für Ortsnamenforschung*, Vol. 2, 1926, pages 12–31). The student of plant geography often wishes, so far as possible, to reconstruct the natural vegetation cover of a region as it existed before modification by the hand of man. In doing this he may supplement strictly botanic or phytogeographic evidence by the examination of documentary records and place names.

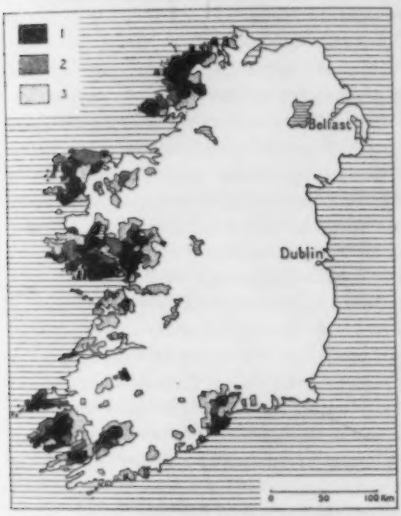
Troll reports the results of a study of the place names in the environs of Munich. In common with other parts of Germany much of this region is now covered with spruce and other coniferous growths, which have taken the place of the hardwoods that prevailed before the Thirty Years War. We find here a frequent use of the toponyms *Buche* and *Loh* and their derivatives, either standing alone or in combination. The term *Buchet* is now applied in the vicinity of Munich not only to beech but to spruce groves. *Loh*, which is etymologically related to the Latin *lux*, means, strictly, a light wood; but Troll finds cases where open, wholly unwooded meadows are called *Loh*.

Not only has Troll been able by the compilation and comparison of data of this sort to show that hardwoods formerly prevailed as a whole over large parts of his area, but he also has succeeded in tracing even the detailed pattern of the former forest cover by correlating the critical place names with the edaphic conditions. In many instances the distribution of the place names containing the stems *Buche*, *Loh*, and *Heide* correspond very neatly with the distribution of various types of glacial deposit. For instance, the *Buche* names seem to be restricted to the moraines and to the outwash plains of the older glacial epochs. The outwash plains of the latest glacial epoch (Würm) were covered largely with mixed oak forest. The approximate areas of former heathland—once much more widespread than now—are seen from the distribution of the word *Heide* (heath) as a toponym to have been restricted to the long tongues of gravel deposited by northward-flowing glacial streams.

Irish and Welsh Speech in the British Isles. The map, Figure 1, of the Gaeltacht, the Irish-speaking districts of Ireland, is reproduced from the *Annales de Géographie*

for March, 1927. It is based on the detail maps (1 mile to 4 inches) of the Coimisún na Gaeltachta, whose report was published by the Dublin Stationery Office in 1926. A similar map and a full analysis are given by Edwin Fels in "Die Wiederbelebung der irischen Sprache" (*Petermanns Mitt.*, Vol. 73, 1927, pp. 37–41).

The census of Irish speakers was made in July and August, 1925, while agricultural statistics were being gathered and before arrangements had been made for the general census of 1926. The results are a matter of concern for those who see in the language the strengthening of the national spirit. The number of Irish speakers has declined from 436,758 in 1911 to 299,249. At the same time the Gaeltacht has lost



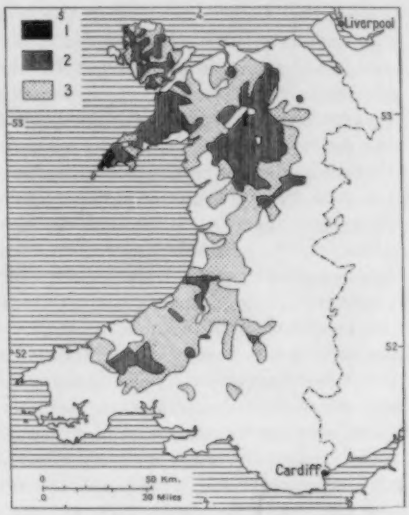


FIG. 1—Irish-speaking districts of Ireland: 1, over 80 per cent of the population speak Irish; 2, 60 to 80 per cent; 3, 30 to 60 per cent. Reproduced from M. Demangeon's note "La situation linguistique et l'état économique de l'Ouest Irlandais" in the March, 1927, number of the *Annales de Géographie*.

FIG. 2—Welsh-speaking districts of Wales: 1, over 80 per cent of the population speak Welsh; 2, 50 to 80 per cent; 3, 30 to 50 per cent. Redrawn from Trevor Lewis' paper in the September, 1926, number of the *Annales de Géographie*.

13 per cent of its total population, which is a considerable share of the 5 per cent loss for the Free State as a whole (1926). The remoteness of western Ireland has been a protection for the language in the past, but the economic conditions associated with that remoteness have reached a state where they now are a factor in the decay. Large numbers have had to emigrate, while those at home remain in "grinding poverty" (compare the article on Inishmore elsewhere in this *Review*). Irish speech has become "a symbol of poverty and ignorance." The Gaeltacht is largely coterminous with the Congested Districts as first outlined. Little has been done to relieve the worst areas, where conditions are "so serious that every responsible authority hesitated." The Commission recommends the breaking up of the western grasslands and their resettlement into economic holdings by Irish-speaking families. If the language is to be saved, however, it is in education that the chief means is to be found.

Some similarities are seen in the survival of Welsh in Wales (Trevor Lewis: Sur la distribution du parler gallois dans le Pays de Galles, d'après le recensement de 1921, *Ann. de Géogr.*, Vol. 35, 1926, pp. 413–418). Over the entire country a certain number of Welsh speakers are to be found but a considerable percentage only in the remote parts—the northern peninsula and the "holy" island of Anglesey; the high

valleys of the northern mountains, which conserve very ancient racial elements; the mountainous zone of the center and south: poor country, a land of emigration. Religion—the non-conformist movement beginning in the eighteenth century—has been a powerful factor in the preservation of the language, while the present development is closely bound up with renaissance of Welsh nationalism in the nineteenth century.

ASIA

The Sultanate of Muscat and 'Oman. 'Oman, the eastern projection of Arabia, is a country of rugged mountains carved out by the erosion of uplifted plateaus. Were it not for this bold relief 'Oman would probably be as unrelieved a waste as the unknown deserts that border it on the west. The highlands, however, catch and condense moisture brought by the monsoons from over the Indian Ocean, producing periodic rains which supply enough water in the wadis to support an agricultural population that, for Arabia at least, is relatively dense. The mountains run out to the north as a long promontory, which nearly closes the entrance to the Persian Gulf. Here the coast has been drowned, forming deep, fiord-like bays, not long ago the haunt of pirates. Winding back among hills of appalling aridity, these bays support a scanty fish-eating population amidst heat that is probably as fierce and overwhelming as anywhere on the earth's surface. Farther south the mountains swing away from the shore of the Gulf of 'Oman as a shallow arc, leaving a narrow, curving coastal plain over two hundred miles long. Where this arc again touches the coast, Muscat, nominally capital of 'Oman, clusters tightly about its tiny, landlocked harbor. Muscat was famous in the sixteenth century as a great Portuguese naval and commercial base and in the seventeenth and early eighteenth as the capital of a veritable Arab empire—that of the *saiyyids*—with possessions on the east coast of Africa even as far as Zanzibar. Closely linked with lands beyond the seas, Muscat is effectually cut off from its own hinterland by the hills, so that the sole means of direct communication with the interior is over "narrow and rough footpaths suitable only for pedestrians and donkeys." Caravans come down to Matrah, two miles away, whence goods have to be shipped to Muscat by boat.

At the present time the Sultan—of the same line as the great *saiyyids*—"has authority only in Muscat and a stretch of coast to the north and south, which can be intimidated by British gunboats." The interior is quite independent; several of the powerful tribes, however, are strongly sympathetic with the Wahabis, and British statesmen are apprehensive of a possible Wahabite conquest of the entire country.

Inner 'Oman has been visited by only about half a dozen Europeans. The latest extended journeys were those of Sir Percy Cox. Although these were undertaken in 1903 and 1905, an account of them was not published until 1925 (Percy Cox: Some Excursions in 'Oman, *Geogr. Journ.*, Vol. 66, 1925, pp. 193–227). In 1925 Capt. G. J. Eccles and a party representing the D'Arcy Exploration Co. carried out a geological reconnaissance of the coastal plain and valleys heading back into the mountains northwest of Muscat. The results of this exploration with a general account of the geography and political situation in 'Oman (from which the above quotations are taken) is published in the *Journal of the Central Asian Society*, Vol. 14, 1927, pp. 19–42.

Structural Features of the West-Siberian Plain. Based upon the results of previous investigations and researches, some of the most important of them published since 1914 or still in manuscript, Y. S. Edelstein contributes to the fifth volume of the *Izvestya* of the West-Siberian Section of the Russian Geographical Society a "Geological Sketch of the West-Siberian Plain." This region, comprising almost the entire basin of the Ob and extending eastward to the Yenisei, forms one of the great

structural plains of the world. Except in the border zones skirting the highlands which surround it, its strata, so far as has been ascertained, lie flat and undisturbed. Only in the southern part of the plain proper, in the regions about Omsk, the fossil fauna of which were disputed over for many years, are there evidences of formations as old as Pliocene and Miocene exposed over any considerable areas. Elsewhere, with rare and insignificant exceptions, are found only Quaternary deposits, mainly of sands and clays, the latter largely of loess-like character, forming the foundation for the black soil of the south-central zone. Glacial deposits extend over a northern portion much more restricted than in European Russia, hardly reaching south of 62°.

The elevation of the entire plain is extremely low, being less than 250 feet in even much of the southern portion, and most of it has been submerged again for considerable periods since its first emergence in the late Paleozoic or early Mesozoic era. Even slight epirogenic disturbances have sufficed to bring about extensive transgressions of the Arctic Ocean. Such transgressions, in the Mesozoic era and well into Tertiary times, reached a junction with the waters of the Aralo-Caspian basin and abraded the older dislocated rocks of the eastern slope of the Urals to a level with the plain itself. Cut off finally on the north and southwest and partly freshened by streams, the remaining waters formed throughout the Miocene and Pliocene epochs an inland sea which was brought into contact with the Altai and Kirghiz highlands by a slip and depression of the eastern portion of the plain along a fault marked by the present course of the Yenisei.

The formation of successive series of dunes along the shore of this sea as it receded is held by some writers to account for the long, low ridges with northeasterly axes which give the only variety to the topography of the southern steppe zone. But this explanation of them is not wholly satisfactory, and several others have been suggested, the simplest being that, since the two principal river arteries of this zone, the Ob and the Irtish, had become established since preglacial times in a northwesterly course, their tributary streams would take northeasterly and southwesterly directions, leaving such ridges between their valleys. A further tilting of the plain from south to north in the postglacial period is indicated by river terraces showing a relative lowering of the base of erosion due to the rise of the southern region, while maritime deposits above the glacial boulder clay in the north are evidences of a new transgression of the sea caused by temporary depression.

The data upon which this sketch is based are scanty, and it is subject to revision by further investigations, for which there is much room. It is noteworthy that in an appended bibliography of about a hundred titles, about one-third deal with the bordering mountainous regions rather than the plain itself, while many more are of general or incidental character. Nevertheless the sketch is a valuable summary of the results arrived at and the problems on which fresh light is needed in the study of this important region.

J. V. FULLER

Physiographic Effects of the Japanese Earthquake of 1923. An excellent study by Naomasa Yamasaki, professor of geography in the Tokyo Imperial University (Physiographical Studies of the Great Earthquake of the Kwanto District, 1923, Reprint from *Journ. Fac. of Sci., Imp. Univ. of Tokyo*, Sec. 2, Vol. 2, 1926 (pp. 17–119), describes the physiographic effects of the Japanese earthquake of 1923, there known as the Kwanto earthquake, from the name of the coastal lowland on which Tokyo is situated.

Before the block faulting, which gave the stamp to the pre-earthquake topography, the district appears to have been a lowland of degradation, worn down on folded Paleozoic and Tertiary strata and more or less veneered with sands and gravels. In consequence of strong downwarping and faulting, the lowland became indented by the large and deep, south-opening Sagami Bay, 80 kilometers across by 110 kilometers

long, in the mouth of which the volcanic island of Oshima has been built up; and also by the smaller and shallower Bay of Tokyo, which branches northeast from Sagami Bay. The Boso Peninsula stands between the two bays and the Pacific on the east; and the Idzu Peninsula, bearing the several medium-sized volcanoes of the Hakone district, stands between Sagami Bay and Suruga Bay of similar origin on the west. Conversely, in consequence of upfaulting, several crustal blocks, now maturely dissected, gained sub-mountainous forms; the loftiest of these being the Tanzawa block, about 25 kilometers northwest from the head of Sagami Bay, with summits from 1500 to 1670 meters high. Besides these stronger depressions and elevations numerous blocks of smaller and diverse displacement are described in detail; their scarped margins, with relief of 200 or 300 meters, are ravined, and their back slopes are dissected by consequent streams, the initial back-slope surface being in some cases well represented in tabular hilltops of accordant heights; but one river, the Hikichi, in the lowland north of Sagami Bay, is regarded as antecedent, as it is believed to maintain its original course into and across an uplifted block.

One of the smaller downfaulted blocks, now forming an aggraded trough about 15 kilometers wide, trending southeast, leads Sakawa River to the head of Sakawa Bay, beneath which the trough is continued in an axial depression with depths of 1000, 1500, and 2000 meters, increasing southeastward to the ocean. This trough appears to show the maximum downward displacement of the region, while the Tanzawa block shows the maximum upward displacement. Next east of the trough of Sakawa River, on the lowland margin, is the uplifted and tilted Yurugi block, rising northwestward, or inland, to a scarped point, and sloping southeastward so as to be continued through the bay in a tilted block, with depths of from 500 to 1000 meters, next east of the axial trough.

The epicentrum of the earthquake was determined by Imamura from seismographic records at Tokyo to be in the depressed axial trough near the middle of Sagami Bay, of which a revised naval chart, No. 102, was published in 1915. Four hydrographic surveying parties were sent to the bay after the earthquake, and 83,286 new soundings were made there. A comparison of these with soundings of earlier dates shows a sinking of 140, 110, 100, and 210 meters along the axial trough and of 120 meters west of Oshima; while a part of the tilted block in the northeast section of the bay next east of the axial trough was elevated from 100 to 250 meters, and an area northwest of Oshima was elevated 100 meters or more. Doubts have been expressed as to these measures of changed depths, but it is precisely in detailed work of this kind that the Japanese excel. The shores of the bay were uplifted from 1.5 to 2.00 meters, laying bare many strips of abraded rock platforms. This small elevation of the shore belt gradually decreased inland, until a belt of land trending west from Tokyo and then southwest into the Idzu Peninsula was found to be depressed from 0.3 to 1.6 meters. The changes of level on the land are shown in great detail on a colored map, 1:200,000, accompanying a volume entitled "Scientific Japan, Past and Present," Kyoto, 1926, prepared for the Third Pan-Pacific Science Congress, held in Tokyo in 1926. (The same volume also contains an article on "The Great Earthquake of S. E. Japan on Sept. 1, 1923," by Dr. Imamura, professor of seismology in the Tokyo Imperial University.) Many small scarps and clefts were developed among the jostled blocks of the coastal lowland; certain large rice fields, previously level, were given a gently waving surface like that of ocean swell; other fields were slightly dislocated by many small step faults; many landslips occurred in the deep valleys of the Tanzawa mountain block. But these minor changes all appear to be of secondary importance: the main movements were renewed displacements on the strong faults which long ago produced Sagami Bay; the Kwanto earthquake of 1923 may therefore be regarded as merely the latest of many previous shocks in this district of jostled fault blocks.

W. M. Davis

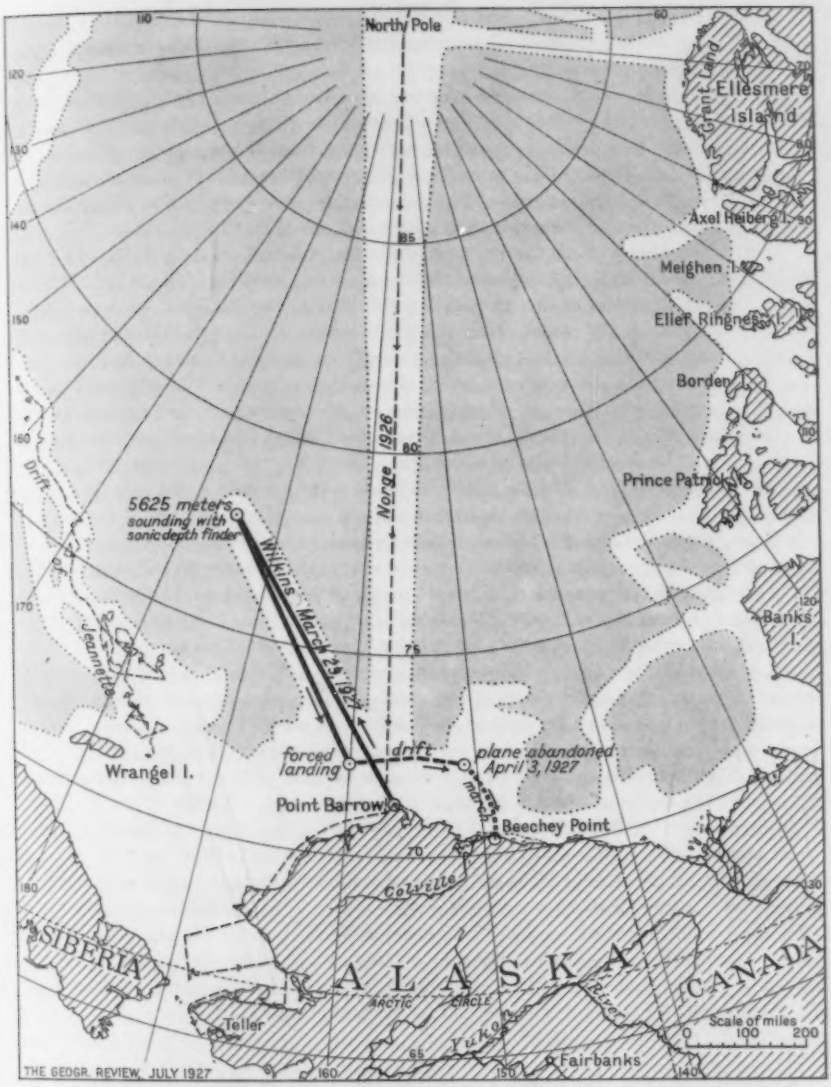


FIG. 1—Map to illustrate Captain Wilkins' route March 29 to April 14. The heavy solid line represents the course by airplane; the broken line, drift on the ice; the dotted line, march over the ice. Unknown areas of the Polar Sea are shaded. Scale 1 : 20,000,000.

POLAR REGIONS

Captain Wilkins' Arctic Expedition of 1927. Some results of Captain G. H. Wilkins' Arctic work of this year are now known in outline. The plans of the 1926 expedition were continued (see *Geogr. Rev.*, Vol. 16, 1926, p. 149; Vol. 17, 1927, p. 317). The first objective was penetration of the unknown area between the drift of the *Jeannette* and the route of the *Norge*. On March 29, in a Stinson plane with Ben Eielson as pilot, Wilkins took off from his base at Point Barrow, intending to fly some 500 or 600 miles northwestward. Five hours out, having flown 553 miles,

the plane was forced down. The landing spot was selected and a perfect landing accomplished. The geographical position was longitude 175° W., latitude 77° 45′ N. Through a hole cut in the ice, here three and a half feet thick, soundings were taken with a Behm echo sounding machine of the light and portable type furnished by the American Geographical Society. From four detonations two echoes that checked were obtained. Despatches received state the depth as 5625 meters or 18,450 feet—the greatest depth reported in the Arctic. While data are not yet available for checking the exact figure the sounding may be taken as over 5000 meters and as further evidence in support of Nansen's theory of a deep polar basin.

After three hours' work the party was able to take off, only to be forced down again in a few minutes, once more achieving a perfect landing. Thus Wilkins' ideas regarding the character of the ice covering this part of the Polar Sea seem to be confirmed. He asserts that frozen into the Alaskan ice are great floes of old ice which behave essentially like land masses, the younger ice piling up on their borders while the interior remains substantially level. On taking off again a strong wind southwest by west was encountered, necessitating an allowance of 30° for drift and greatly reducing the speed. In consequence seven hours later, when 470 miles of the return trip had been made, the gasoline gave out. They were now in latitude 72° 15′ and longitude 160° W., 83 miles northwest of Barrow in the stormy coastal belt. The floe they landed on drifted rapidly to the east, a direction contrary to the usual westward drift, which would have taken them towards Wrangel Island. By April 3 they had drifted 167 miles to the east, to longitude 151° W. and latitude 72° 15′. Here Wilkins decided to leave the plane and strike south for the Eskimo settlement and trading station of Beechey Point, at the mouth of the Colville River. With an improvised sled they set off shoreward, after 12 miles crossing from a floe drifting eastward to one drifting slowly westward. Wilkins' calculations proved exact: in twelve days they reached the station. The going was exceedingly rough, especially over the shore ice, where they dispensed with the sled. A good deal of game was seen on the march, but provisions carried with them sufficed for their needs. Nights were spent comfortably in snow houses. Eielson had a badly frozen finger, but otherwise no serious mishaps befell them.

From Barrow, Wilkins flew via Wainwright and Kotzebue to Fairbanks in order to make preparations for further exploration. On May 29 he flew back to Barrow, crossing the Brooks Range by the Anaktuvuk Pass. If conditions had permitted he would have undertaken a second trip across the ice. The season, however, was far advanced and the spring breakup had come early this year. The proposed flight would have penetrated the most important remaining unknown area, that is the region northeastward where Crocker Land and Bradley Land have been reported. At the moment of going to press it seems probable that Wilkins' plans will be continued next year.

Kerguelen Island. Kerguelen Island, discovered by the Chevalier de Kerguelen in 1772 and claimed by him for France, received little official notice until 1893 when it was formally annexed by that nation. So unattractive as to be termed "Isle of Desolation" by its early visitors, the island has for the most part remained hidden in its mists, being visited only by whaling vessels and occasional scientific expeditions.

Kerguelen lies midway between the Cape of Good Hope and southwestern Australia in latitude 49° S. With a length of 85 miles and an area of 1400 square miles, the coast line is penetrated by so many deep fiords that no part of the island is more than 12 miles from the sea. Soundings support the theory that Kerguelen was once part of an extensive land area that included the present Crozets, St. Paul, and Amsterdam Islands. The island itself is volcanic with basaltic rocks and hot springs. Bearing evidences of glaciation, its mountains rise in series of jagged peaks, Mt. Ross attaining an elevation of 6120 feet. The scenery is magnificent, for the steep-

sided valleys open out upon the deep fiords, snow fields cover the interior, and occasional glaciers descend from the heights. Although the presence of trees at one time is indicated by the petrified tree trunks, the island is now devoid of tree growth. The present vegetation is of great antiquity, having no affinity with that of Africa. The rocky coasts are covered with tufted, grassy growths. The Kerguelen cabbage, much valued for its antiscorbutic qualities, takes its name from this island. Vegetation disappears above an elevation of 300 meters, and the soil becomes a field of basaltic rock with intervening spaces of sand and shallow pools. The interior is a complete desert, neither birds nor insects remaining there.

Lying within the zone of the cold Antarctic drift, with a low temperature and high precipitation, the fall of rain and snow is considerable. The chief characteristic of the weather is the frequency of storms and high winds at all times of the year. These storms blow principally from the west. A high wind is the rule each week, and any month may bring snow. Yet the meteorological reports of one expedition show that fully half the sky was generally clear at some time in the twenty-four hours (S. J. Perry: Report on the Meteorology of Kerguelen Island, *British Meteorol. Office Publ. No. 37*, 1879; B. M. Varney: Climate and Weather at Kerguelen Island, *Monthly Weather Rev.*, Vol. 54, 1926, pp. 425–426).

Kerguelen is frequented by fur seals and sea elephants, and the surrounding waters by whales. Whaling vessels early discovered this, and the exploitation of these animals has led to their depletion. Aside from the seasonal visits of the whalers, no commercial exploitation of the island was undertaken until 1893, when the Bossière Brothers, who had been engaged in raising sheep in the Falkland Islands, obtained the whole island as a concession from the French Government. The more orderly exploitation of the seals and elephant seals, together with the setting aside of certain parts as a national park, points to a permanent and valuable trade in these animals. Sheep raising, for which the Bossière concession was granted, is still in an experimental stage (Ct. Sauvaire-Jourdan: La mise en valeur des îles Kerguelen, *La Nature*, No. 2743, 1926, Oct. 30, pp. 273–279).

OCEANS

The Oceanography of the Eastern North Atlantic. The very marked differences in climate and habitability that characterize Labrador and Greenland on the one hand and northwestern Europe on the other can in no wise be attributed to differences in latitude, for these countries face each other across the intervening waters of the North Atlantic Ocean along the same parallels of latitude. These differences arise primarily from differences in the oceanographic conditions of the eastern and western parts of the North Atlantic Ocean. The circulation in this ocean is such that the warm waters of the Gulf Stream are carried toward its northeastern rim, making it possible for the winter winds, which here are southwesterly, to ameliorate an otherwise more northerly climate. The countries facing the eastern North Atlantic are thus very profoundly modified in their climatic features by the oceanographic conditions of the waters washing their shores.

To the elucidation of these oceanographic conditions the veteran Norwegian oceanographers, Bjørn Helland-Hansen and Fridtjof Nansen, present a detailed study in "The Eastern North Atlantic" (*Geofys. Publikasjoner*, Vol. 4, No. 2, Norske Videnskaps-Akad. i Oslo, 1926). This study is based principally on their own observations made during five cruises in the *Armauer Hansen* in the years 1913 to 1924, but use is made also of the data provided by other expeditions in these regions. In this connection it is interesting to note that, although the observations made by the authors extended to a depth of more than a thousand fathoms, the *Armauer Hansen* is a small sailing vessel, with auxiliary motor, of 58 tons' burden and about 80 feet long.

On the basis of these observations, which are given in detail in three tables and summarized in a number of dynamic charts, the authors present a picture of the physical conditions in the eastern North Atlantic. In the region west of Europe they find these physical conditions "dominated by the great North Atlantic Current, popularly known as 'the Gulf Stream'." Coming from the west this North Atlantic Current passes over the Atlantic Longitudinal Ridge, turns southwestward and divides into two branches, the main body of the current turning northward while the other branch turns southward. A continuation of the northerly branch finds its way into the Norwegian Sea.

In the distribution of temperature and salinity in this area another factor becomes prominent and modifies somewhat the simpler features due to the North Atlantic Current, especially at some distance below the surface. This factor is the intrusion of a considerable mass of saline and relatively warm Mediterranean water. At a depth of about 600 fathoms Helland-Hansen and Nansen find the influence of this water from the region near the Strait of Gibraltar to extend as far north as Ireland.

Attention is directed by the authors to the importance of vertical oscillations in connection with oceanographic observations. They present evidence in support of such oscillations partaking of the periodicity of the tides. The observations appear to indicate a period of half a day near the coast and a period of a day farther out in the open sea. These are matters about which very little is yet known, and in directing attention to the vertical oscillations the authors state that these oscillations "have obviously to a great extent some connection with the tides; but how the tidal wave can produce vertical movements of such dimensions in the different strata of the sea seems to us at present to be inexplicable. We have here a phenomenon of fundamental importance to Oceanography, which has to be made the subject of special methodical investigations."

Interest attaches to a short series of current observations made on Rockall Bank, out in the open sea some 200 miles due west of the Hebrides. Here a rotary tidal current was found, the direction of rotation being distinctly clockwise. In discussing these observations the authors call attention to the fact that from the generally accepted direction of the tidal wave in this region a counterclockwise direction of rotation might be expected. The thesis recently elaborated by H. U. Sverdrup in his "Dynamic of Tides on the North Siberian Shelf," that the rotary character of tidal currents on continental shelves arises primarily from the deflecting force of the earth's rotation rather than from the interaction of tide waves traveling in different directions, might be put forward to explain the action of the current here; for in consonance with Sverdrup's theory the direction of rotation of the tidal current in the northern hemisphere, except where influenced by special hydrographic features, should be clockwise.

In the foreword to their study the authors state that the present treatise "makes no claim to have reached definite conclusions in regard to a number of highly important questions; for in spite of the very ample material in the form of observations there are still great gaps, and far more complete and systematic investigations will be needed before the problems can be definitely solved." However, in the observations made by the authors and in the discussion of these observations and their correlation with previous data, a considerable step forward has been made not only in arriving at a better understanding of the conditions in this region but also in a clear statement of the nature of the factors and problems involved. H. A. MARMER

The Actual Numbers of Deep-Sea Soundings. In an article under the above title in the *Scottish Geographical Magazine* for July, 1926, Henrik Renqvist summarizes the present state of knowledge of the depths of the open sea as illustrated by the actual numbers of soundings in the various oceans. The present is an appropriate time for such a survey, since the use of acoustic methods of sounding the oceans

marks a new period in oceanographic work. Where a deep-sea sounding with wire was a matter of hours, a similar sonic sounding is a matter of minutes.

Starting with the assumption that the last edition of the Prince of Monaco's bathymetric map shows practically all the deep-sea soundings made heretofore, Renqvist arrived at the number in each ocean by the simple process of counting. He lists the number in each of the three oceans—Atlantic, Indian, and Pacific—and then computes the average density per unit area. Taking a deep-sea sounding to be one greater than 1000 meters (approximately 3300 feet, or 550 fathoms) he finds the total number of such soundings in the three oceans to be, in round numbers, 15,000, of which 6100 are in the Atlantic, 2500 in the Indian, and 6300 in the Pacific.

Taking the areas in each of these oceans in which the depths are greater than a thousand meters and dividing by the number of soundings given above, Renqvist finds that in the Atlantic Ocean there is one sounding for each 5500 square miles, in the Indian Ocean one for each 10,500 square miles, and in the Pacific one for each 10,000 square miles. This means that in the Pacific Ocean there is, on the average, but one sounding for areas greater than that of the State of Massachusetts.

Obviously the figures for the average density of soundings do not tell the whole story. Within the regions of the more moderate depths (1000–4000 meters) the number of soundings is relatively much greater. Furthermore, the soundings are not evenly spaced, being most dense along lines of soundings, especially those made in connection with the laying of telegraph cables. If the 15,000 deep-sea soundings be plotted as dots on a chart, the resulting net would be one of irregular mesh, and a number of these meshes would each be nearly as large as all Europe.

H. A. MARMER

The Tide at Tahiti. The rise and fall of the tide is brought about by both sun and moon, the moon, however, playing the leading rôle; or, as it is put colloquially "the tide follows the moon." This is perhaps best evidenced by the fact that throughout the world, almost without exception, the tide like the moon comes later each day by fifty minutes, on the average.

Tahiti furnishes a striking exception to this general rule. Here the tide appears to follow the sun, high water coming every day about noon and midnight and low water about six o'clock in the morning and six o'clock in the evening. This peculiar behavior of the tide at Tahiti has been known for some time. In "Omoo," which appeared in 1847, Herman Melville states "The Newtonian theory concerning the tides does not hold good at Tahiti; where, throughout the year, the waters uniformly commence ebbing at noon and midnight, and flow about sunset and daybreak." Writers of the more popular type of travel books have been less restrained than Melville and either state or imply that at Tahiti the tide ebbs and flows with unvarying regularity never changing in time from one year's end to another. Indeed, a recent popular book quotes a mariner as saying that from the verandah of his club at Papeete he could tell the time of day within a quarter of an hour by looking seawards and seeing where the water stood!

Our knowledge regarding the tide at Tahiti has been meager, for it has been based on a few short series of observations made a number of years ago. Recently, however, at the instance of the U. S. Hydrographic Office, an excellent series of automatic tide records covering several years has been secured by Mr. Harrison W. Smith of the Massachusetts Institute of Technology, who was sojourning in Tahiti. An analysis of these observations has been made by the tidal mathematicians of the Coast and Geodetic Survey, and the results are now at hand.

The mean range of the tide at Tahiti is 0.8 foot. At full and new moon, when the so-called spring tides occur, the range increases to a little over a foot, while at the time of the moon's first and third quarters—neap tides—the range is but little more than half a foot. In general it may be said that high water comes a little after noon

and midnight, and low water a little after six o'clock, both morning and evening. But it must be emphasized that this is only on the average. From day to day the time of the tide varies, but this variation only infrequently is as much as three hours from the average values. During spring tides, when the rise and fall is most noticeable, the time of tide varies but little from the average values. The principal lunar component of the tide (in the harmonic notation M_2) has an amplitude of 0.29 foot, and the principal solar component (S_2) an amplitude of 0.26 foot. In other words, here the solar component has very nearly the same amplitude as the lunar, whereas generally it is less than half as large.

Two explanations for this anomalous behavior of the tide have been put forward. The earlier one was based on the assumption of two tide waves coming from different directions, the lunar constituents of which had approximately equal ranges but were six hours apart in time, so that the high water of the one coincided with the low water of the other. The lunar tide was thus very largely neutralized, which permitted the solar tide to become very nearly as prominent. The later explanation is based on the stationary-wave theory of the tide which conceives the tidal movement as due to systems oscillating about nodal lines. Under this theory Tahiti lies near one nodal line of a lunar oscillating system, making the lunar tide here small.

H. A. MARMER

MATHEMATICAL GEOGRAPHY

Oscillatory Changes in the Earth's Radius. When all known factors have been taken into account, theoretical prediction of the moon's position during certain periods has been known to be as much as fifteen seconds of arc in error. At present it is an accepted hypothesis that the effect of tidal friction is responsible for a gradual retardation in the rate of the earth's rotation; but this, being a secular change, does not account for the fluctuations in the moon's apparent movements. Ernest W. Brown, in the *Transactions of the Astronomical Observatory of Yale University* (Vol. 3, 1926, pp. 205–235), presents the evidence which shows that the fluctuations of the apparent movements of the moon and sun are real and not the results of errors in observation. He suggests an hypothesis to explain the phenomenon and arrives at conclusions that are of importance to the geophysicist as well as the astronomer.

The evidence, an analysis and comparison of all the available material collected since 1621, seems conclusive. The hypothesis is that the observed fluctuations of the moon are due to variations in the earth's rate of rotation, when these are combined with the known effects of tidal friction. Granting the hypothesis, arguments resulting from astronomical data, mechanical laws, and geophysical evidence point to the conclusion that such variations can arise only from vertical oscillations of the whole crust of the earth, the source of these oscillations being oscillatory changes that take place in the isostatic layer or below it. The maximum change of the average radius of the earth needed by the astronomical data is between five inches and twelve feet, according to the hypothesis made as to the depth of the source.

Professor Brown's hypothesis has attracted wide attention, and several reviews of his paper have already resulted. Among these may be mentioned "Les variations dans la rotation de la terre," by J. Boccardi (*Rev. Gen. des Sci.*, Vol. 38, 1927, No. 3), and "The Variation of Latitude and the Fluctuations in the Motion of the Moon," by Walter D. Lambert (*Journ. Washington Acad. of Sci.*, Vol. 17, 1927, No. 6). In the latter paper it is pointed out that "the difficulty with the hypothesis—other than the primal one of finding a cause for the shrinking and swelling—lies in the matter of sea level." Mention is also made of the suggestion by Professor J. W. Evans that "a not unreasonable change in the volume of the circumpolar ice sheets might affect a change in the moment of inertia of the earth sufficient to cause the irregularities in its rotation that are reflected in the apparent errors in the lunar tables."

PHYSICAL GEOGRAPHY

De Geer's Interpretation of Climate by Clay Deposits. In a couple of short papers Professor Gerard De Geer has recently announced remarkable climatic correlations between Sweden and North America and between the northern and southern hemispheres (On the Solar Curve as Dating the Ice Age, the New York Moraine and Niagara Falls Through the Swedish Timescale, *Geogr. Annaler*, Vol. 8, 1926, pp. 253–284; Late Glacial Clay Varves in Argentina, *ibid.*, Vol. 9, 1927, pp. 1–8). The periods of time involved are the Late Glacial and the Postglacial. The method is known to most geographers and geologists from De Geer's earlier papers. It consists in the measurement and comparison of varved clays that register the annual sedimentation in an unmistakable and characteristically banded pattern. Through the work of De Geer in Sweden and North America and of his students in the Himalayas (Norin), eastern North America (Antevs), and Argentina (Caldenius) he is able to put together "curves" of variation that show a striking degree of correspondence, roughly 80 per cent. Of the correspondence itself there can be no doubt, despite marked departures here and there as "accidents" of one sort or another occurred in the drainage systems in which the varved clays were deposited.

Professor De Geer had two major problems to face in extending his correlations across the Atlantic and into the southern hemisphere. He had first to construct a standard of reference, and this he did by working out a Swedish time scale which takes account of the whole interval from Late Glacial down through Postglacial time to the present. Probably not more than a century separates the last records of the series from our own time. A continuous varve series covering the whole of the Postglacial epoch was obtained by Lidén in the Valley of Ångermanälven which "seems to be the only region of the earth, where it is possible to connect the glacigene part of the timescale with our actual [i.e. present] chronology." The finding of varved clays in Postglacial deposits that carry the glacial record down practically to the present supplies a yardstick for the measurement of events in the late history of the earth which has been supplied by no other discovery in earth science since its beginning. The significance of De Geer's studies can scarcely be overestimated, because they shed light upon so many problems that are directly related to mankind. There is shown to be in the first place a very short interval since the close of the Glacial period. The record has been traced back over 18,000 years, and it is concluded that 8700 years of this period represents Postglacial time. The standard year marking the division between these two epochs is taken to be the time of final draining of the greatest ice lake dammed up between the waning ice remnant in the Scandinavian Peninsula and the Scandinavian mountains. It was then that the once extensive glacial masses of northern Europe had practically melted away and their scanty and half-stagnant remnants became divided up into different parts. In a few hundred years more these remnants totally disappeared, leaving only local mountain glaciers as at present.

From this conclusion and the present known facts of man's antiquity it is seen that man occupied the earth long before the last maximum glaciation. It is clear, then, that he must have been seriously affected by these major climatic pulsations and that his occupation of northern Europe must have followed rather closely the retreating ice cap. The rate and manner of reoccupation of the surface by vegetation is only second in interest to that of the human problem involved. From the peat bog records it seems equally clear that vegetation followed closely the retreating ice border. By a comparison of the Swedish and North American varved clays science can refer American glacial and postglacial events to the Swedish time scale. Thus the age of Niagara Falls can be recalculated. To it De Geer assigns a value of 9500 years, rather than the larger values that have ranged up to 25,000 and even 50,000 years. It would require too much space to develop the argument in detail and to

show how many relationships of moraines to lake beaches and to varved deposits have to be taken into account in arriving at the final computation. Still more complicated is the problem in the Scandinavian region, where the uplift and warping of the terraces, beaches, and border deposits have formed a tangled record that has required a lifetime to study and interpret. It is perhaps sufficient to say by way of review that the work has been carried out most conscientiously and with a rare devotion.

The most remarkable results of De Geer's method have followed upon a comparison of varve records from Argentina and Sweden. It can be readily understood that the climatic variations of the northern hemisphere may have been synchronous and that deglaciation may have proceeded in a general way uniformly in both Europe and North America. But a complication results when we go into the southern hemisphere. If the change in the thickness of the varves from year to year is dependent upon a solar cause and if that solar cause is shown to operate over the northern hemisphere rather uniformly, we might expect it to be hopeless to attempt a comparison between records from the northern and southern hemispheres, for in the southern hemisphere the variations in temperature might on theoretical grounds be conceived to be in opposite phase—only the warm melting season of each hemisphere is registered in the sediment. But, concludes De Geer, a wave of heat lasted over the *greater part of a year*, thus being registered in both hemispheres. Moreover, there is in the solar curve not infrequently a two-year period representing a sustained maximum as if the heat were carried over from one melting season to another, the continued effect of radiation lasting over a twelvemonth. De Geer suggests a special astronomical study to determine at which part of the earth's orbit the earth receives such excess of heat, so that we may understand the relationship between the beginning and the end of associated northern hemisphere and southern hemisphere summer varves "which together represent the whole of what could be called a *thermal year*." He advances various possibilities and closes thus: "It would be curious indeed, if the olden traces of the sun in clay and mud should lead to new astronomical results."

Thus for the first time there have been correlated certain specific climatic changes over the whole earth, and the changes have been dated with respect to the present. By this wide correlation a framework has been built up whose parts can now be filled in. The main Quaternary glaciations of the earth corresponded in time. They had a common cause in the changes of heat received by the earth from the sun rather than in changes of precipitation. The clays are nature's great recording instrument by which we can not only date events in Late Glacial and Postglacial time but also observe variations in solar radiation itself. This last result is by no means of minor importance. The thickness of the bands themselves seem directly related to the amount of melting and that in turn to the amount of heat received, so that thin varves mean years of lower temperature and thick varves (in general) years of higher temperature. De Geer rightly emphasizes the great importance of such a record of the sun's radiation extending back 18,000 years as compared with the brief instrumental records in meteorology and astronomy.

The next critical steps in checking the chronological correlations will no doubt be taken in North and South America. In New England, Antevs has done more than apply De Geer's method—he has analyzed the fundamental postulates of the method and, more especially, has studied the basis of correlation itself. It is expectable from his brilliant results that modifications, some of them fundamental, will in time be made. This is the natural evolution of scientific thought. No one generation can settle definitively the working of natural laws; even the number of dimensions of our modern world has changed! It is greatly to Antevs' credit that he has concentrated on this great problem and with painfully small sums of money supplemented by complete devotion has carried forward his research along original lines. ("The Recession of the Last Ice Sheet in New England," *Amer. Geogr. Soc. Research Ser. No.*

11, 1922, and "The Last Glaciation with Special Reference to the Ice Retreat in Northeastern North America," a forthcoming volume in the *American Geographical Society's Research Series*.) Many others will in time extend his work, but none we may be sure will surmount greater difficulties.

HISTORICAL GEOGRAPHY AND HISTORY OF GEOGRAPHY

The Islands of the Blessed and Atlantis. Mysterious isles in the far western seas played an important part in the mythological geography of the Greeks—Elysium, the Islands of the Blessed, the Gardens of the Hesperides, Scheria or the Island of the Phaeacians, Syrie, the isles of Calypso and of Circe, and others. Adolf Schulten would seek the prototypes of these in Madeira and the Canaries, with which the Islands of the Blessed (Fortunatae Insulae) were identified by later geographers of antiquity ("Die Inseln der Seligen," *Geogr. Zeitschr.*, Vol. 32, 1926, pp. 229–247). He thinks there is no doubt that the Greeks knew of the Atlantic by 1000 B. C. through contacts with the Phoenicians. These adventurous traders had passed through the Pillars of Hercules at least two hundred years earlier in their voyages to Tartessus (Tarshish), the great silver and tin emporium, which Schulten places near the present site of Cadiz (see Schulten's "Tartessos," 1922). "In the seventh century, the time of the Homeric and Hesiodic poems, Greeks themselves penetrated to the Ocean—Phocaeans, who soon established very friendly relations with the silver city [Tartessus]."

The various attributes of the western isles as described in the Homeric and Hesiodic poems correspond closely to those of an island which Diodorus (Hist., v, 9–10) places off the west coast of Africa. Both have a mild and delightful climate, very fruitful soil, an abundance of woods and streams; and in both man may live almost without effort on the bounty of nature. The island which Diodorus describes can be no other than Madeira. He refers to its discovery by the Phoenicians shortly after the founding of Gades (Cadiz), 1100 B. C., and mentions a subsequent attempt of the Etruscans to establish a colony there—an attempt that was frustrated by the Phoenicians. In the Odyssey an isle of Syrie, the home of Eumaeus, is mentioned and is said to have been visited by the Phoenicians. Schulten believes that this can be no other than Madeira, "which [the Phoenicians] discovered and defended so carefully against foreign visitors, the name Σύρη itself seeming to point to the Phoenicians, or the 'Syrians.'"

Schulten also tackles the Atlantis story and lists no less than sixteen different details mentioned in the Platonic story which might well apply to Tartessus. Atlantis, Plato reported, was said to have sunk suddenly into the sea as a result of earthquakes. "This might well be a poetic explanation of the fact that Tartessus disappeared at one stroke from the horizon of the Greeks after its destruction by the Carthaginians and the closing of the straits [of Gibraltar]. But, perhaps, the story may be taken literally, for it seems that the vicinity of Tartessus had sunk, as well as the city itself. And when Plato says that the Ocean became shallow and impassable owing to the sunken Atlantis, I discern here the influence of Carthaginian reports of shoals and other dangers, given out after the destruction of Tartessus in order to frighten away foreign sailors."

A new theory of Atlantis is proposed by Paul Borchardt (*Petermanns Mitt.*, Vol. 73, 1927, pp. 19–32), who brings the country described by Plato, on the authority of Solon, within the Straits of Gibraltar, assuming that the term "Pillars of Hercules" did not refer to Calpe (the Rock of Gibraltar) and Abyla at the time when Solon heard the story from the Egyptian priest of Sais. The term might have been applied to any temple of Melkart (Hercules), for in these temples two columns were set up as symbols of the god of maritime traders (see also R. Hennig: Zum Verständnis des Begriffs "Säulen" in der antiken Geographie, *Petermanns Mitt.*, Vol.

73, 1927, pp. 80–87). Such a temple stood near the site of Gabes on the Lesser Syrtis, and it is here that Borchardt locates the entrance of the "Sea of the Atlantes," which most students from the time of Plato onward have taken to mean the Atlantic Ocean. This sea, which the earthquake caused to become impassable, Borchardt identifies with a deep gulf that once may have occupied the present site of the Shott el-Jerid west of Gabes and have communicated directly with the Lesser Syrtis. The plain of Atlantis he believes was a broad region lying south of the *shotts*, historical and physiographical evidence seeming to show that in early times this was more fertile than now. The difficulty raised by Plato's reference to Atlantis as an island Borchardt explains away; the word "island" was often used by the classical geographers in speaking of tracts of land well defined by rivers or mountains. He would, therefore, identify Atlantis with northwestern Africa as a whole. He also points out many resemblances between the names given in Plato's narrative and the tribal and place names of this part of Africa.

In a symposium of articles on the Atlantis problem (*Petermanns Mitt.*, Vol. 73, 1927, pp. 143–152) Dr. Albert Herrmann of Berlin defends Borchardt; Professors E. F. Gautier of Algiers and Fritz Netolitzky of Czernowitz attack his theory; and Borchardt himself replies to his critics.

Both Schulten's and Borchardt's hypotheses are more reasonable than much that has been written on this difficult subject. Neither scholar would rake up the bottom of the Atlantic Ocean nor flood the Sahara, doing violence to geology. Borchardt asserts that with the exception of Pierre Termier (see *Geogr. Rev.*, Vol. 3, 1917, pp. 61–66) there is "scarcely a geographer of the present day who believes that within historic times a great island of Atlantis has sunk beneath the Atlantic Ocean." The question, however, is one which will never be definitely settled, unless, possibly, as Borchardt suggests, by means of excavations. Atlantis will long tempt the ingenuity of scholars and lure the uncritical into fantastic realms of pseudo-scientific speculation.

GEOGRAPHICAL NEWS

Obituary

Charles Redaway Dryer. Charles Redaway Dryer died at Fort Wayne, Ind., on March 21, aged 76. [Latterly Professor Dryer adopted "Redaway" for "Redway."] His geographical work was done as a teacher: here he was a pioneer of new ideas and methods, worked out for the most part in the Indiana State Normal School where he was professor of geography and geology from 1893 to 1913.

A generation ago Professor Dryer urged the humanizing of the physical geography of the day. The science was treated "almost as if men only visited the earth occasionally, but did not live on it," he wrote in an autographed copy of his book "Lessons in Physical Geography" (1901) in the Society's library. He was an ardent advocate of the natural-regions conception of Herbertson and made it the culminating part of his excellent textbook "High School Geography: Physical, Economic, and Regional"—revolutionary among American texts when first published in 1911. The idea also permeates his "Elementary Economic Geography," first published in 1916. Professor Dryer also expounded his views in the paper "Natural Economic Regions" in the *Annals of the Association of American Geographers* (Vol. 5, 1915) and in "Studies in Economic Geography" in the *Geographical Review* (Vol. 2, 1916). His practical philosophy is stated in his presidential address before the Association of American Geographers (*Annals*, Vol. 10, 1920). Reference should also be made to two papers on the history of geographical education: "The New Departure in Geography" in the *Journal of Geography* (Vol. 11, 1912–1913) and "A Century of Geographic Education in the United States" in the *Annals of the Association of American Geographers* (Vol. 14, 1924).

GEOGRAPHICAL REVIEWS

The British Isles

Albert Demangeon. **Les Iles Britanniques.** viii and 320 pp.; maps, diagrs., ills., bibliogr., index. (Géographie Universelle, Vol. I.) Librairie Armand Colin, Paris, 1927. 80 fr. 11½ x 8 inches.

The world geography series planned by Vidal de la Blache, and already in preparation before the war, is now making its appearance under the editorship of Professor Lucien Gallois. The first volume, "Les Iles Britanniques," is by Professor Demangeon and is a pure delight. Paper, typography, photographs, line drawings are a joy to the eye: it is hardly necessary to say in the preface that the editor has given "every care to the illustration of the volume"—it speaks for itself. To pick out one or two examples only is not easy; one might mention the graphic series of little maps showing the seasonal distribution of the herring fisheries (p. 49); such regional maps as that of the Lake District (p. 147) or of the Northumberland and Durham coal field (p. 155). The fine conception of line is well exemplified in the map showing the distribution of dolmens in western Europe (p. 70).

The text has the exquisite clarity of the line drawings. M. Demangeon's dealing with fundamentals secures simplicity and breadth. "This frequency of contact, this repeated opposition of highlands and lowlands may be considered as the distinguishing feature of the country: the origin of local contrasts, it multiplies the small natural settings, the regional individualities" (p. 20). This with the accompanying map is the keynote of the section on relief. "The relations between the Irish and the English are in fact a page in the colonial history of England" (p. 83) is the thread running through the discussion of these relations. Added to this, careful choice of words and selection of detail create an intimate and penetrating picture. Take, for instance, the author's sketch of Edinburgh," . . . the irregular ground of the site, the gardens and trees, the majesty of the monuments, the distant and picturesque perspectives give the city a charm unique in Great Britain." And "among the great British cities Edinburgh is as unique in its functions as its appearance . . . In this Great Britain which knows not a centralization such as that of France the national temperaments have not been fused in an amalgam . . . Edinburgh is essentially a Scottish capital: . . . it is not a maritime town nor an industrial metropolis: . . . but a town of spiritual values, of science, of law, whose most specialized occupations are printing and publishing with the trades and materials dependent on them. . . "

Or take this picture of the industrial towns of the West Riding of Yorkshire:" . . . they resemble one another superficially as children of the same family. They cover a great area, for the workers live in one-family houses: and these houses, all lined up in interminable rows, are built on identical plan in identical mold: under the clouds of smoke from factories and mills they exude an air of melancholy monotony." And by way of contrast in the rural Vale of York, the old town a capital since Roman days, "whose brilliant medieval past survives in its cathedral and walls: . . . the narrow winding streets, the overhanging timbered houses, the massive tower of the old castle, the ruins, and charming corners breathe of another age and diffuse calm and peace."

Or the Forest of Dean, " . . . a little forested plateau whose rocky walls are washed by the Wye above its junction with the Severn . . . the fine oak wood that has escaped the secular deforestation, the clumps of old beeches and fine hollies

. . . " And its unique coal field, whose mines" . . . worked in the open forest, under the shade and greenery of the trees, escape the sadness of the black country . . . the miners dwelling in the little towns that girdle the border of the forest."

It is seldom that any unfamiliarity is betrayed. In paying just tribute to the University College of Wales at Aberystwyth for the study of Welsh culture (p. 82) the fact is overlooked that, for lack of a natural center in Wales (compare p. 81), the University is constituted by three colleges, in the north, center, and south, and that while the National Library is in Aberystwyth, the National Museum, another expression of the Welsh national spirit, is in Cardiff. In a few instances the distinction between regional and administrative lines might have been a little clearer; in treating of the Welsh border country, for instance. And again mere addition of a statement to the effect that Middlesborough, Darlington, and the Cleveland district are in Yorkshire would have appeased the pride of the reader from that county who finds them described under "Northumberland and Durham." York became the seat of an archbishopric—instead of bishopric—in the seventh century. But such minutiae merely throw into relief Professor Demangeon's remarkable knowledge of and feeling for the spirit of the country.

In treatment the book is well balanced. Following M. Gallois' foreword and an introduction on the individuality of the British Isles and their place in the world are three sections dealing respectively with general considerations, regional studies, and economic life and relation to the Empire. Needless to say, the succeeding volumes of the series, all by well known French geographers, are eagerly awaited.

Scandinavian Wall Maps

Alfred Söderlund, edit. **Europa: Befolkningskarta (Population Map), 1: 4,000,000.** In four sheets. Generalstabens Litografiska Anstalt, Stockholm, 1926. 20 kr.

Alfred Söderlund and Gustav Törnblom. **Kommersiell Världskarta.** 1: 35,000,000. Generalstabens Litografiska Anstalt, Stockholm, 1926.

"Europa" is an admirable colored wall map on the "absolute" point method, a development from Sten De Geer's large map of Sweden and Dr. Söderlund's map of Norway. Cities of a hundred thousand or more persons it shows by red spheres of size proportional to the number of inhabitants, a white "brilliant point" suggesting the sphericity to the eye. The rest of the population is indicated by cleverly placed little red dots a 30th of an inch in size, one for each 5000 persons.

Names of the cities indicated by spheres and about as many more of less size, names of countries, rivers, etc. are in black. Coast lines, seas, and rivers are in blue. The colors are pleasing and transparent. Canals are indicated and mountains located by their names, without relief shading of any sort. A selection of railroads is printed in a clear but unobtrusive gray, like the main sea routes. Beside each city sphere a small number in black notes the number of times 5000 persons it had in 1920; thus, 20 indicates 100,000 persons, which needs rather fuller explanation in the legend than it has obtained. It would have been much better to have indicated the numbers in thousands. Broad bands of gray outline De Geer's "industrial regions." In Russia the southern limit of forests is marked; and in Russia, Finland, Sweden, and Norway, the northern border of tillage.

All this is done without crowding or obscuring the map. The selection of matter to be represented from the multiplicity that offered has been admirably made. The map gives a remarkable picture of human distribution in Europe on an unwontedly large scale; but the scale is none too large for this essential feature of geography which up to the present has suffered incredible neglect. The map should be in every

schoolroom where advanced study of Europe is made, in spite of our American shyness of foreign languages, which makes the place names look queer.

The representation of non-urban population by a dot for each 5000 persons is most severely tried in sparsely settled areas like Norway. Where people live on isolated farms or in little villages, it is most arbitrary and artificial to gather 5000 of them into a single spot on the map. Tinting a whole county with one shade of population density was, in general, no further from the truth. The map does not give a good idea of the way the inhabitants of Norway and northern Sweden cling to the coasts and the linear river valleys, as shown on the large maps referred to above, on which a dot represents 100 persons. For the English Midlands, however, 5000 to a dot is none too many, if enough white background is to show through to keep place names clear. So the method called "absolute" is relative after all!

However, De Geer and Söderlund have made it possible to learn needed detail about Norway and Sweden; and the method has been applied most skillfully even in sparse populations, as is proved in the treatment of Iceland by the clever way in which the ninety-odd thousand inhabitants are distributed about the fiords. More detail is here given of the human occupation of Iceland than has ever come under the observation of the reviewer.

"Kommersiell Världskarta" is a clever and distinctive wall map. The map is an oval "Hammer's equal-area planisphere," the equatorial scale being about 1 : 35,000,000. It is neatly printed in colors and not at all overloaded with names. It shows fixed air routes and makes a special feature of telling a Stockholm merchant what language to use in writing to any country. This information embodies the advice of Swedish consuls abroad and is most interesting. For instance, German is to be used in sending orders to Germany, Poland, Czechoslovakia, Austria, Hungary, and Switzerland, and may be used instead of Russian for Russia; for Yugoslavia either German or French; and for Brazil either German, French, or English. For Spain and Spanish America Spanish only is recommended. For Portugal and its colonies, for Italy and colonies, as well as for Egypt and the Belgian Congo English or French should be used. English is to be used for the United States and for the British domains, of course; and also for China, Japan, and Arabia, with the permitted alternative of French. French should be used in French domains and also in Greece, Rumania, Bulgaria, Turkey, and Persia. In Addis Ababa the activities of Scandinavian missionaries have made it possible for the Swedish merchant to write in "Scandinavian"!

Another feature of the map is the annual tonnage of great ports. Sea routes are given as they are actually steered, not as generalized; and there is some indication of temperatures and the ice-drift border.

Readers will get an exaggerated impression of the preponderance of Swedish steamer lines if they take the map at face value. Red seems to be the Swedish color, and all the lines converging on eastern ports in the United States are red. The map is small, and when something had to be left out it wasn't Swedish!

MARK JEFFERSON

Norden. 1: 1,500,000. In 2 sheets. Swedish text. Lithographic Division of the General Staff, Stockholm, 1926.

This wall map of Fenno-Scandia, Denmark, and vicinity represents an outstanding contribution to the fields of economic and commercial geography and cartography. Its large scale and pleasing color scheme provide for clear legibility at long range. At close range its numerous details are easily read. The data include not only the official reports of the respective countries here delineated but also the researches of such geographers as Sten De Geer, Söderlund, and others.

Elevations above sea level for every 500 meters, to a height of 2000 meters, are shown in varying shades of olive; while ocean depths are indicated by shades of blue

for every 500 meters to a depth of 2500 meters. The first 500 meters below the sea are interrupted by one shade to represent the 200-meter contour. Glaciers appear in light mottled blue.

Of particular interest is the distribution of the cultivated areas, colored yellow. In those parts of Sweden and Finland bordering the Gulf of Bothnia and extending an irregular distance inland, delimited for the most part by the landward margin of the coastal plain, the rural population flanks the rivers which flow down to the gulf in parallel directions. Interstream areas are essentially unoccupied. By contrast, in the south of Sweden, in Denmark, and even in southern Finland the farm areas are commonly continuous between streams. The interpretation of the distribution along the rivers differs among geographers, some assigning such reasons as protection and convenience of transportation as fundamental, while others find the attraction of the waters and the food supply offered by them as basic. In any case, a cross section from south to north as revealed by the yellow color emphasizes the relation between the stage of economic development of a people and the element of location.

Appropriate symbols show national and provincial boundaries, sizes of cities, location of villages, castles, churches, cathedrals, national parks, railroad routes, steamship courses with amount of traffic moving along them, and still other political and economic information contributing to a description of man's activities in the region. A small inset map, to show the means of communication between Fenno-Scandia and North Sea points, adds further value. The North German and Polish coasts, Danzig Free State, the new Baltic States south of Finland, and a strip of adjacent Russia shown in some detail assist one in orienting the main areas with respect to Europe and at the same time give good balance to the entire map.

Unfortunately, meridians are numbered with reference to Stockholm, the longitude of the latter east of Greenwich being noted in order to facilitate calculating the longitude of other points east of Greenwich if desired. This arrangement is awkward and seems to serve no good purpose. Parallels of latitude are drawn for each degree, and the subdivision of the degrees is supplemented by figures along the left-hand margin indicating 2.5 centesimal intervals. An index plan involving the standard combination of numerals and letters serves to add further to the convenient use of the map.

EUGENE VAN CLEEF

REGIONAL STUDY IN ESTONIA

J. RUMMA, J. G. GRANÖ, and J. V. VESKI. **Tartumaa: Maadeteadusline, majandusline ja ajalooline kirjeldus.** xvi and 740 pp.; maps, diagrs., ills., indexes. (Eesti: Maadeteadusline, majandusline ja ajalooline kirjeldus, I.) Eesti Kirjanduse Seltsi kirjastus, Tartus, 1925. 9½ x 6½ inches.

The young Estonian state intends to investigate its virgin territory, for the former Russian government was more interested in such parts of its empire as the Ural and the Caucasus, on account of the great economic importance of their mountain lands; whereas the Baltic region, which is but poorly endowed with minerals, was almost completely neglected. In Estonia there has been created for the purpose a Society for Home Geography (Kodu-uurimise Toimkond), which in collaboration with the Estonian Literary Society (Eesti Kirjanduse Selts) intends to publish a great collective work on Estonia in eleven volumes. As the first volume there appears a substantial book on the County of Tartu (Dorpat), entitled "Tartumaa," containing many very useful statistical data. The land and the people of Estonia are the subjects of the investigation, the following questions being treated: location, morphography and geomorphology of the land, waters, vegetation, animal life, regions as well as the settlements, communications and economic conditions, cultural and hygienic questions.

MICHAEL HALTENBERGER

Some German Works on Political Geography

Otto Maull. **Politische Geographie.** xiv and 742 pp.; maps, index. Gebrüder Borntraeger, Berlin, 1925. 10½ x 7 inches.

Walther Vogel. **Politische Geographie.** 134 pp.; maps, bibliogr. (Aus Natur und Geisteswelt No. 634, Allgemeine Geographie X.) B. G. Teubner, Leipzig and Berlin, 1922. 7 x 5 inches.

Walther Vogel. **Das neue Europa und seine historisch-geographischen Grundlagen.** 2nd edit. x and 322 pp.; maps, bibliogr. Kurt Schroeder, Bonn and Leipzig, 1923. 9½ x 6½ inches.

Rudolf Reinhard. **Weltwirtschaftliche und politische Erdkunde.** 196 pp.; maps, diagrs., bibliogr. Ferdinand Hirt, Breslau, 1925. 9 x 6 inches.

Political geography is still merely a term, not a science. It is unnecessary to suppose that it ought to be a science when one undertakes to appraise or to criticize current works on the subject. Necessarily its facts are drawn to a large degree from economics and general history as well as from the fields of international relations and diplomatic history; but the essence of the subject is the geographical basis or background for political events and relationships. Geography offers not merely a technique, such as maps, demographic studies, and statistics peculiarly its own; it offers much more, namely, organized expert knowledge of what we may call the regional set-up of the world. It is peculiarly the function of geography to furnish the scientific basis for a study of man as actually distributed in the world region by region. However much he may respond to economic laws of world-wide scope and however large or small may be the national units that make the political framework of the world, the intimate life of people is much more affected by the regional conditions of their living, the physiography, the climate, the soil, and the special relationships of the local environment.

To seek a meaning from the cultural landscape as derived from the natural landscape is at least understandable; to go further and see culture as a self-stimulating force rise superior to the natural limitations of its place of origin, is sound; and it is true that superior culture is often superior strength and thus a spreading and transforming force. But do we derive inevitably from this a conclusion respecting the justice or injustice of boundaries? By specious scientific systems we may argue for any desired political result. Some of the most important elements of culture seem not to get into the political geographies of continental Europe, namely, ethics, good manners, the elevation of fairness into a fine art, *cultured* living! The historical argument against a given boundary solution is arid. The world moves on. Where do we stand today? What is fair now? To take another aspect of culture—machine power—a single invention may throw a nation into a wholly new economic status. Machinery changed the world in a generation. What do the advocates of "white men's lands" care for philosophic niceties and traditional political modes? If man's culture rises above his environment so does man rise above his culture, if we may express it paradoxically. With many deep roots in his past he yet frames new systems as spontaneously as life succeeds itself. Forms, cultures, judgments, standards float upon a current that flows always in a temporary channel.

In an earlier number of the *Review* (review of Supan's "Leitlinien der allgemeinen politischen Geographie: Naturlehre des Staates," *Geogr. Rev.*, Vol. 14, 1924, pp. 665–666) we criticized a European type of philosophy that attempts to put political geography largely within the framework of the state as at once an expression of culture and the guardian of it. This is to start with a political theory devised to aggrandize the state, and it may have nothing whatever to do with the actual facts of living. We now come to a group of publications that illustrate other aspects of the subject.

Professor Maull's book is packed with historical and economic information from

a wide variety of sources, and there are many excellent and attractive illustrations and generalizations respecting the economic and political life of man on the earth. In addition, there are many ingenious ideas and relationships; much matching of the different irregular parts of the world's picture puzzle. But if we look for judgments respecting the political set-up of the world today or if we look for any rational information of use to policy makers in government we find the book singularly deficient. For practical purposes the information is put into unwieldy form, and much of the lore is simply a mass of notes of antiquarian interest but of no practical or theoretical importance in government or geography. To put facts into a series, to invent mnemonic schemes is to achieve neither learning nor science. No one could use such information as a basis of forecasts; one can rarely demonstrate the cause of a given development in any case. One can only suggest reasons for historical unfolding or for possible action today. After all, a map of Europe which shows by broad arrows (p. 637) the different lines of force of the great powers of Europe teaches us nothing that we need to know or have not already learned; and merely as graphics it is open to objection because it is partial. The illustrations of "disharmonic states" (p. 623), as, for instance, the western border of Germany, northwestern Italy, and eastern Persia, bring into juxtaposition environments and cultures so totally different that to classify them as common examples of a principle is to say nothing at all. A prime illustration of the fault of the mnemonic principle is the table on pages 120–121, classifying the nations of the world according to population and area. Again, as a mnemonic this may have usefulness; but as an illustration in support of a discussion of the space requirements of peoples it does not make sense at all. If we compare nations by area we find Germany put in the same general class with Paraguay, and if we compare broad population categories in the same table we find ourselves looking at a group which includes Liberia and Norway and other equally strange bedfellows such as Afghanistan and Chile. The author takes over from Supan the extraordinary table of "colonial quotients," showing the ratio of the area and population of the colonial possessions of the powers with the motherland. Of course England stands at the head with a quotient of 8.4, while Germany has a "quotient" of 0.2; but of what significance is that when the Netherlands has a quotient of 6.2 and Portugal and the United States are respectively 1.7 and 0.1 (p. 125)? Of a similar order is the world map on page 147 showing by excellent symbolism the states having two, three, four, five and more neighbors on their borders. After all, neighborship, if we may so term it, may be the least of one's problems. It is not how many neighbors but what kind of neighbors that counts, and what is the length of the border of friendly and unfriendly neighbors, and how one is situated with respect to one's allies. Thus, too, on page 186, is a discussion of the relation of the geomorphological space types of states, that is the relation of states and state boundaries to the physical set-up. Likewise, plant and animal analogies and homologies are suggested here and there. But all to what purpose?

One can understand much better the two smaller works listed herewith, Vogel's "Politische Geographie," a general discussion of the field (as well as his "Das neue Europa," which deals more fully with each nation), and Reinhard's "Weltwirtschaftliche und politische Erdkunde." The former writes more specifically: his illustrations are fewer, his whole scheme is more modest, his feet are on the ground. Witness his map showing the steppe regions of Central Europe, carefully thought out, showing at a glance more than do a dozen pages of philosophic sleight of hand. He is not unaware of the philosophy of his associates, but he cuts through it to arrive at the specific and the practical and actual relationships rather than at any possible philosophical meanings of such relationships, for the ultimate meanings are really denied to man! Intensely German in spirit and politics, he writes in a form often unacceptable to a non-European; but at least one can make allowance for that, whereas the "philosophy" of his associates leaves only bewilderment.

In a still more specific way Reinhard discusses international relations of raw materials and, in short, the material basis of our civilization. His map illustrations are numerous, his whole style of thought less philosophizing, more apprehensible. He expresses practically no opinions and draws no profound conclusions, but he puts facts into striking relationship and lets the inevitability of their meaning stand in place of personal opinion.

Arabia and the Arabians

Paul W. Harrison. **The Arab at Home.** xii and 345 pp.; map, ills., index. Thomas Y. Crowell Co., New York, 1924. 8 x 5½ inches.

A. Goodrich-Freer (Mrs. H. H. Spoer). **Arabs in Tent and Town: An Intimate Account of the Family Life of the Arabs of Syria, Their Manner of Living in Desert and Town, Their Hospitality, Customs, and Mental Attitude, With a Description of the Animals, Birds, Flowers and Plants of Their Country.** 325 pp.; ills., index. Seeley, Service & Co., Ltd., London, 1924. 8½ x 5½ inches.

Mrs. Steuart Erskine. **The Vanished Cities of Arabia.** 324 pp.; ills. Hutchinson & Co., London, n. d. 9 x 6 inches.

Eastern Arabia was the scene of Dr. Harrison's twelve years of field service as a medical missionary. His work for the American mission in the hospitals at Kuwait, in the oases of Nejd, Al Hasa, and Mesopotamia, among the mountains of Oman, and in the open desert, brought him into close contact with Bedouin, townsman, and agriculturist alike. Clearly and forcefully he sets forth the fruits of long observation of the material and spiritual conditions of Arab life in the communities he visited. One cannot but wonder, however, whether these communities are sufficiently typical to warrant the use, without further qualification, of the very broad title, "The Arab at Home."

Dr. Harrison examines minutely the social and economic conditions of Bedouin and oasis life and makes these the subject of illuminating comparisons. To the pearl-diving industry of the Persian Gulf, in which "probably a hundred thousand Arabs are engaged . . . throughout the summer months," Dr. Harrison devotes a chapter of altogether exceptional interest. As a missionary the author was above all concerned with the religion of the Arabic people. Like others before him, he sees in Mohammedanism a reflection of the desert: "Mohammedanism is little more than the Bedouin mind projected into the realm of religion. The Arab faces God as he faces the desert. Here is a vast omnipotent environment, which rules his life and which reduces him to insignificance and even nothingness in comparison. By conformity to its laws he hopes to live, and as a usual thing he can. But there is an element of caprice about the desert which makes it at times utterly cruel and ruthless, and from that ruthlessness no amount of humble acquiescence or of vigilant effort will save him. This is exactly the picture of the Moslem God. Unlimited omnipotence, governed as a usual thing by law, and usually rewarding obedience with His favor, He is still tinged with unaccountable and unpredictable caprice, and is essentially pitiless in His power and magnificence. It is the image and superscription of the desert. Long before Mohammed wrote this picture of God into the Koran, God Himself created it in the desert, and so stamped it on the Bedouin's heart."

The subtitle of Mrs. Spoer's "Arabs in Tent and Town" gives a fairly precise idea of the scope of her book. Years spent in the towns and villages of Syria and along the desert borders, combined with a sympathetic spirit and a knowledge of Arabic, gave Mrs. Spoer rare opportunities for observing the lives of a people, many of whose customs date from the days of Abraham. A gift for winning the confidence of the Arab women enabled her to gain an insight into local tradi-

tions, popular mentality, and the intimacies of family life such as few Europeans have been privileged to obtain. She discovered ethical refinements in Arab civilization of which we in the West have no parallel, as, for instance, the Bedouin code of hospitality. For this, the desert environment is, perhaps, ultimately responsible, though Mrs. Spoer asserts that "in its wider and less individual presentation, as active philanthropy, hospitality has always been an inherent part of the religion of the East; a necessary part of Oriental life." Mrs. Spoer's chapters on the weather and on natural history relate mainly to the native's attitude and the folklore regarding these matters. She gives, however, a particularly graphic account of the great invasion of locusts in the Jerusalem district in 1915.

Let us not quarrel with Mrs. Erskine's use of the title "The Vanished Cities of Arabia", though we must confess that on first seeing it our thoughts were carried far southward, to the tombs of Hejr visited by Doughty fifty years ago, or the mysterious city—Gerrha, perhaps—recently found by Cheesman at 'Oqair on the Gulf of Bahrein, or possibly to Sabaean and Himyaritic ruins on the margins of the great southern desert. With none of these Mrs. Erskine is even remotely concerned. The book, with its truly magnificent illustrations, deals with ruined cities in the rift valley of Syria and on the plateau east of the Jordan and Dead Sea—Petra in its cleft rock, the towering Crusaders' castle of Kerak, the ill-fated "cities of the plain": Philadelphia, Gerasa, and others. It is a pleasant combination of history and travel, informative but not heavy. Students of the history of geography will turn to the chapter on the discovery in 1894 and subsequent partial mutilation of the famous mosaic map of Palestine at Madeba, dating from the time of Justinian (sixth century of our era).

Nomad and Agriculturist in Western Turkestan

Paul Kunhenn. **Die Nomaden und Oasenbewohner Westturkestans.** 131 pp.; bibliogr. Heinrich Pöppinghaus, Langendreer, 1926.

Even though its author has neither visited Western Turkestan nor made use of Russian sources, this doctoral dissertation by a young disciple of Passarge is of distinct value. From the point of view of human geography, the region with which it deals is more or less typical of the entire zone of deserts and dry steppes stretching from the Atlantic coast of the Sahara far into the heart of Asia. Hence, many of Kunhenn's observations and conclusions relating to the desert and oasis dwellers of Turkestan would hold equally true for Arabia or North Africa. Furthermore, his treatise is well planned and clearly presented.

The most striking fact in the human geography of the Africo-Asiatic desert and steppe zone is the dualism of the population. Even where they have sprung from the same racial stock, the desert rover and the oasis dweller are different in almost every respect. The distinction between nomad and settler is fundamental, far more profound than the distinction between townsman and farmer in lands of European civilization.

After a brief sketch of the physiography of Western Turkestan, Kunhenn examines the contrasts between the nomadic herdsmen of the steppes and the Sarts, or oasis folk, in respect to social, political, and family life, to religion, law, occupations, means of subsistence, clothing, habitations, manners and customs, and to physical and spiritual qualities in general. Most of these contrasts may be attributed to the differences between the desert and oasis environment. In the desert, man's foremost enemy is nature. Life is a constant struggle for mere existence in the face of extremes of cold and heat, with the menace of drought and famine ever at hand. The nomad is wholly dependent upon his herds, around the preservation of which the entire course of his life revolves. This means periodic seasonal migrations to and from summer pastures among the mountains or on the cooler, damper steppes to the

north. In the oases, which cluster along the bases of the mountains and about the deltas of the greater streams far out in the desert, plenty of water is distributed by irrigation over rich fields of loess, and there has grown up an enormously dense population. Here man's primary struggle is with his fellow man.

Kunhenn shows how these contrasting environments have fostered, on the one hand, the hardy, simple, independent, democratic, dirty, meat-eating, and naturally religious nomad, and, on the other, the oasis dweller, effeminate, complex, servile, keen-witted, meticulous about his person, a vegetarian, and, though fanatically Moslem and scrupulous in the observance of religious forms, fundamentally irreligious at heart. Kunhenn considers that Islam is "a typical oasis religion" and that the reason why it was accepted so rapidly in Turkestan at the time of the Moslem conquest is that it was admirably adapted to the mentality of the oasis dwellers. Although nominally accepted by most of the nomads, Islam with them is in reality little more than a veneer over the "Shamanism which they have brought with them from regions further east." The nomad has no genuine conception of the unity and omnipotence of God. In this respect his religious outlook differs essentially from the inborn monotheism of the Bedouin even though both are children of the desert.

The Vegetation of Algeria and Tunisia

Augustin Bernard and R. de Flotte de Roquevaire. **Atlas d'Algérie et de Tunisie, Part IV: Carte de la végétation.** 4 pp.; map, diagrs., ills. Gouvernement Général de l'Algérie, Direction de l'Agriculture, du Commerce et de la Colonisation, Service Cartographique, Algiers and Paris, 1925. 24½ x 21 inches.

René Maire. **Carte Phytogéographique de l'Algérie et de la Tunisie.** 78 pp.; maps, ills., bibliogr. Gouvernement Général de l'Algérie, Direction de l'Agriculture, du Commerce et de la Colonisation, Service Cartographique, Algiers, 1926. 10½ x 8½ inches.

These two publications describe the vegetation of the same area and are accompanied in each case by the same colored phytogeographic map. The map is the work of Professor Maire, assisted by MM. Battandier, G. Lapie, P. de Peyerimhoff, and Dr. Trabut. The former publication gives a concise description of the vegetation and carries 13 half-tone illustrations, which are well selected to portray the larger aspects of the principal vegetations. A series of four profiles is given with the same coloring used in the phytogeographic map. The second publication describes the vegetation in greater detail and is accompanied by 60 illustrations of individual species. The vegetation of Algeria and Tunis falls into three natural subdivisions, the lightly forested coastal region, the steppes which skirt the landward side of the broken mountain region, and the desert region which lies adjacent to the Sahara. The coastal region undergoes a dry warm season of 4 to 5 months but receives an annual rainfall varying from 400 to 1600 mm. Its prevailing vegetation is forest of evergreen oaks (*Quercus Ilex* and *Q. suber*) and deciduous oaks (*Q. lusitanica* and *Q. afarez*), together with the olive and species of elm, ash, alder, and poplar. On the mountains and plateaus lying within 100 kilometers of the sea there are forests of pine (*Pinus halepensis*); on the coast there are a few small areas of *Pinus pinaster;* and on the highest elevations there are small areas of cedar (*Cedrus atlantica*). On some of the smaller mountains bordering the northern edge of the Sahara open forests of *Quercus Ilex* and *Pinus halepensis* are to be found. A small arborescent juniper (*Juniperus phoenicea*) occurs in extensive open stands along the border of the Sahara at elevations lower than those occupied by the oaks. Another small coniferous tree, *Callitris articulata*, is abundant in western Algeria and occurs in smaller areas in Tunis.

Between the forested and desert portions of Algeria are extensive steppes, with 200

to 350 millimeters of rainfall, characterized by an open stand of plants less than a meter in height. The characteristic plants of the steppe are grasses (*Stipa tenacissima* and species of *Aristida*, *Bromus*, and *Koeleria*) and shrubs (notably *Artemisia herba-alba* and *A. campestris*). Many other species of plants are found in the steppe, including numerous ephemeral herbaceous plants. The vegetation of the Sahara is well characterized by both of the authors as being only "rarefied steppe."

FORREST SHREVE

THE COASTAL DESERT OF SOUTHWEST AFRICA

ERICH KAISER. **Die Diamantenwüste Südwest-Afrikas, zugleich Erläuterung zu einer geologischen Spezialkarte der südlichen Diamantfelder, 1: 25,000, aufgenommen von W. Beetz und E. Kaiser.** Mit Beiträgen von W. Beetz, J. Böhm, R. Martin, H. Rauff, M. Storz, E. Stromer, W. Weissermel, W. Wenz, K. Willmann. Vol. 1, x and 321 pp., maps, diagrs., ills.; Vol. 2, vii and 536 pp.; maps, diagrs., ills., index. Dietrich Reimer (Ernst Vohsen), Berlin, 1926. 9½ x 12½.

The reader's satisfaction in the extent and thoroughness of this report will be enhanced by the excellence of the illustrations. A rarely beautiful series of photographs shows typical landscapes region by region as seen from the ground and from the air. Desert filling has nowhere been better illustrated than in Plate 14 which shows by air photograph a group of mountains all but buried under desert waste. The colored frontispieces to the two volumes hint at those inexpressible compositions of light and color that give the desert its peculiar power to haunt the memory. Volume 2 has been thoughtfully provided with two packs of stereoscopic photographs. An elaborate index furnishes a key to the whole work, and there are tables, diagrams, and sketches to illustrate almost every phase of the discussion. Volume 1 is accompanied by a set of detailed relief maps, geological maps and sections, and analyses of the various physiographic and geologic elements. For example, map No. 11 shows in great detail the belt of wandering dunes north of Angras Juntas, one of the best maps of its kind yet published.

The detailed geological maps are of especial interest because the principal object of the work is illustrated in them: the geological development of the region and the origin of the diamond-bearing deposits. The diamonds occur in sandy beds associated with the coast. It is concluded that they had their origin in the interior as elements associated with igneous rocks. The breaking down of these igneous rocks distributed the diamonds throughout a broad sheet of alluvial deposits. These deposits were later reworked especially in the Eocene, and the diamonds concentrated along drainage lines where they are found today.

The most striking feature of the work is the large colored topographic map on the scale of 1 : 25,000, showing by thirteen tints the relief of the land from below sea level to 240 meters above sea level. The large scale and the minute division of the vertical elements of the relief have provided one of the most satisfactory representations of desert topography in existence. In addition to the means of color clever use has been made of shading. Accompanying the map is a separate text published by the Geographical Society of Munich (*Mitteilungen*, Vol. 19, 1926, pp. 38–75). This describes the field methods employed, the development of the cartographic style, and gives a brief summary of the main physiographic features. The underlying structure consists of a series of folded rocks whose axes run for the most part parallel to the coast. The rock itself is mostly gneiss and schist intruded by granite and covered in places by stratified rock. Secondary structural lines are rift valleys traversing the primary structural lines at an angle and emerging at the coast where they form notable elements in the coastal physiography. Besides a high series of coastal terraces whose origin is uncertain there are raised beaches to the height of 40 meters as well as at intermediate levels.

Especially interesting is Kaiser's discussion of the desert topography and the part played by wind in its formation. In the descriptive pamphlet accompanying the map are two block diagrams (pp. 62 and 63) which show the unlike characteristics of two regions: the one shows dominant deflation by strong winds, the other dominant alluviation through the relative weakness or absence of winds. He concludes that southwest Africa has long been subjected to desert conditions, some ancient sandstones showing characteristic dune structure. With the invasion of the middle and upper Eocene sea the climate was modified, moister conditions prevailing. The Miocene was marked by a return to semiarid conditions, and in later times there has been progress to the state of extreme aridity which marks the region today. He concludes that the driest phase of the climate has not been felt in historical times, nor even in human times, but in a pre-human epoch; and that at the present time southwest Africa enjoys a moister climate owing to moderate marine invasions.

On the Mineral Wealth of the Far East

H. Foster Bain. **Ores and Industry in the Far East: the Influence of Key Mineral Resources on the Development of Oriental Civilization.** With a chapter on Petroleum by W. B. Heroy. Preface by E. F. Gay. viii and 229 pp.; maps, diagrs., bibliogr., index. Research Publs. of the Council on Foreign Relations, New York, 1927. 9 x 6 inches.

Wilfred Smith. **A Geographical Study of Coal and Iron in China.** With an Introduction by Percy M. Roxby. 83 pp.; maps, bibliogr., index. University Press of Liverpool Ltd., Hodder & Stoughton Ltd., London, 1926. 5 s. 9 x 6 inches.

C. Y. Hsieh. **General Statement on the Mining Industry (1918–1925).** 4, iv, ii, and 362 pp.; map. *Spec. Rept. Geol. Survey of China*, No. 2, December, 1926, Peking.

In his introductory chapter Mr. Bain refutes two commonly held opinions regarding the Far East—the "untold wealth" that Westerners have always associated with Cathay and the complementary view that the mineral wealth is "unknown" and "almost wholly unmeasured." Actually, says Mr. Bain, a large body of data exists which has not yet found its way into general publications. To this his book, clear and succinct and fortified with an extensive bibliography, furnishes a key, and it reaches the conclusion that, with minor exceptions, "the Far Eastern countries are characterized by deficiency in mineral resources rather than by abundance." At present the contributions of the Far East to the world's mineral products are small save for antimony and tungsten, of which China furnishes respectively 80 per cent and 63; tin, of which Malaya, Siam, and the Netherlands East Indies furnish 60 per cent and China 6 per cent.

The situation would seem to be different with China's coal reserves, which are great whatever estimates be taken. Estimates vary widely. Drake, for the International Geological Congress of 1915 ("Coal Resources of the World") gave a figure of nearly 1,000,000 million tons, a value comparable to the reserves of Europe. On a different basis the Geological Survey of China gave a conservative estimate of 23,000 million tons, a figure which new studies are constantly increasing (see below). In the particular instance of fields in northern Shensi and western Shansi Clapp and Fuller arrive at estimates exceeding Drake's. With the known data it is "impossible to reconcile the figures," says Mr. Bain, but both he and Mr. Smith (see below) regard Drake's figure as being probably on the right order of magnitude.

It is otherwise with iron ore. Here, as regards China we have Tegegengren's careful report, "The Iron Ores and Iron Industry of China" (*Memoirs Geol. Survey of China*, 2 vols. and Atlas, Peking, 1924). He points out that the total quantity of iron ore, 950,000,000 tons (both actual and potential), "would be consumed by the iron industry of the United States within less than nine years." Thus China needs to

conserve her resources for her own future development. The situation is worse in Japan, whose domestic supply is "entirely inadequate to her needs." Among the Far Eastern countries the Philippines and the Netherlands East Indies are also potential producers of lateritic iron ores, but with them the question of coal arises.

Succeeding chapters deal with the other "tonnage" minerals, sulphur and the sulphides, and with petroleum, the non-ferrous metals, and the non-metallic minerals. There follows a chapter of wide interest on "conditions affecting mineral development in the Far East." Men and money and the less tangible factors that will control industrialization of the Far East are considered, briefly but wisely, with China as the case in point. A final chapter is entitled "What of the Future?"

Mr. Smith's excellent little book has the distinctive feature of a geographical background. Chapter I considers China's coal and iron in relation to structure; but, as their economic significance depends also on other geographical factors, in Chapter II he takes up a survey of the deposits by natural regions "each of which possesses some unity of economic life . . . and each of which promises to develop some regional specialization of industry." Chapter III, from the historical angle, discusses briefly the early use of the two minerals in China, the beginnings of large-scale industry through Western contact, and the lines of future advancement. Every large coal-mining enterprise in China is related to railroad communications, and consequently with one exception (Pinghsiang) all are in northern China (see his map on p. 58).

The relation of the coal and iron resources to general industrial development is taken up in the last chapter. Already there are hints as to the future. The Fushun coal field of Manchuria has bean oil and bean cake factories and is introducing the manufacture of chemical by-products. Tatung, on the Peking-Suiyuan railroad, has a woollen factory. The northern fields have back of them the pastoral products of a vast zone in northwestern China and Inner Magnolia. The present distribution of cotton mills, immature as the industry now is, foreshadows establishment of the major manufacturing districts in the Yangtze delta, the Central Basin, and the fringes of the northern plain.

The Geological Survey of China's report on the mining industry is dated December, 1926. The main text is in Chinese, but the more important tables are printed in English also, and there is an English preface. Of special interest is the statement of a reëstimate of the coal reserve giving a total of 217,626 million tons. The report is accompanied by a map showing distribution of the coal fields of China on a scale of approximately 1: 6,750,000, which may be "compared with profit with that of Wilfred Smith." The "variable nature of the data available for different regions" is pointed out, and the reader is cautioned to use the map with reserve "especially so far as the southern or southwestern provinces are concerned." Summary tables give the value of the total mineral production of China (including Manchuria and Outer Mongolia) for 1925 as nearly $258,000,000, of which the metallic minerals, chiefly iron, tin, and antimony, comprises $67,000,000 and coal the bulk (85 per cent) of the remainder.

The Mineral Resources of South America

Richard Stappenbeck. **Karte der Minerallagerstätten von Süd-Amerika.** Scale 1 : 3,750,000. Dietrich Reimer (Ernst Vohsen), Berlin, 1926. M 100. 16 x 11 inches.

Otto Maull. **Südamerikas Bodenschätze als Weltreserve und Machtfaktor, auf Grund von Richard Stappenbecks "Karte der Minerallagerstätten von Südamerika."** *Zeitschr. für Geopolitik*, Vol. 3, 1926, pp. 774–788.

Interest in the mineral deposits of South America has been increasing during the past few decades with the result that there have been many demands made

all over the world for accurate information. The data that have been collected have not been readily accessible. Partially to satisfy this demand Miller and Singewald published their volume on "The Mineral Deposits of South America" in 1918, in which an attempt was made to bring together and summarize existing information, part of which was original but much of which was obtained from the literature or from individuals and mining companies. An adequate map of the continent showing the location of the mineral deposits was considered desirable but could not be included in the volume, and resort was had to the inclusion of small maps of various countries and regions. Without the knowledge of the writers of this volume Dr. Richard Stappenbeck had been collecting data for the preparation of a similar work. After the appearance of their book, he abandoned his former idea and confined his attention to the preparation of a map showing the occurrences of the various mineral deposits of South America. Its publication was long delayed on account of the financial situation in Germany after the war, but with improved conditions the map was published in 1926.

Dr. Stappenbeck was well prepared to undertake the task to which he set himself on account of his first-hand acquaintance with many of the mineral regions of Argentina, Chile, and Peru where he spent 16 years in geological investigations. Only one who has attempted to collect information concerning various parts of South America can properly appreciate the large amount of careful work involved in his undertaking. It is more than a mineral map in that, in addition to the use of 76 symbols representing different mineral products, groups, or varieties of minerals, he has also shown the location of railroads, aerial tramways, oil and water pipe lines, blast furnaces, smelters, coke ovens, and oil tanks and has given many data concerning the navigable streams and water powers, exploited and unexploited.

The scale of the map, almost 60 miles to the inch, does not permit the representation of all the important mineral deposits in certain sections. To overcome this difficulty insets of certain sections on a large scale are given. These include: the gold and platinum placers of the Choco, Colombia (1 : 1,950,000); the highlands of Cundinamarca, Colombia (1 : 1,600,000); the mining district of Central Peru (1 : 1,000,000); the gold mines of Carabaya and Sandia, Peru (1 : 1,600,000); the iron, manganese, and gold districts of Minas Geraes, Brazil (1 : 1,150,000); the mineral deposits of Chile, between Rancagua and Tocopilla (1 : 1,000,000).

Another inset, on the same scale as the main map, shows the location of the important mineral deposits of Central America with a small enlargement of the gold and silver districts of eastern San Salvador.

There is no doubt but that many persons familiar with certain portions of the continent will note inaccuracies in the map; but in the present state of our knowledge of South America exact information for the preparation of an accurate map does not exist. The examination of those portions with which the reviewer is acquainted leads to the conclusion that the work has been done with great care, and the author is to be congratulated on the result. He appeals to the users of the map for new data and criticisms in order that future editions may be more complete.

The publishers have done their part well in that the printing of place names is clear and legible and the symbols in eight colors are readily distinguishable. The map is published unmounted in six sections.

Largely on the basis of Stappenbeck's map Otto Maull has written an essay on "Südamerikas Bodenschätze als Weltreserve und Machtfaktor." One cannot fail to be impressed with the wide variety of mineral products and their abundance in the Andes and the Highlands of Brazil and their infrequency in the great central portion of the continent where, if they exist, they are deeply hidden from view by the thick sediments unassociated with igneous rocks. South America is having its mineral deposits developed rapidly. Besides the mineral districts so well known—such as the nitrate districts of Chile, the copper of Peru and Chile, the vanadium of

Peru, the diamonds, manganese, and monazite of Brazil, the gold of Colombia, the bauxite of the Guianas, and the tin of Bolivia—it may well be that in the future the continent will be called upon to furnish in quantity other mineral products required by the industrial nations of the globe. Petroleum occurrences are widespread and, although largely unexploited, are regarded by many as sufficiently promising to cause South America to take rank eventually with North America in the production of petroleum.

BENJAMIN LEROY MILLER

A CONTRIBUTION TO THE BIOGEOGRAPHY OF ECUADOR

F. M. CHAPMAN. **The Distribution of Bird-Life in Ecuador: A Contribution to a Study of the Origin of Andean Bird-Life.** xiii and 784 pp.; maps, ills., bibliogr., index. *Bull. Amer. Museum of Nat. Hist.*, Vol. 55, 1926. 9½ x 6 inches.

As Dr. Chapman has stated in his earlier publication, "The Distribution of Bird-Life in Colombia: A Contribution to a Biological Survey of South America" (*Bull. Amer. Museum of Nat. Hist.*, Vol. 36, 1917), the purpose of his studies of the bird life of the Andes has been rather to discover the geographic origin of South American bird life than to identify new species. (For a review of Dr. Chapman's earlier volume see Charles C. Adams: The Zoögeography of Northwestern South America (after Chapman), *Geogr. Rev.*, Vol. 10, 1920, pp. 101–107.) His problem, as presented in both this work and the one on Colombia, is to "ascertain the effects on the distribution and evolution of bird-life of the elevation, in comparatively recent geologic times, of a mountain system, the central base of which lies near the equator while its summits reach perpetual snow, the wings extending continuously to the Temperate Zone at the south and, with some breaks, to the same zone at the north." The book is based on specimens collected between 1912 and 1926 by numerous expeditions of the American Museum of Natural History and many additional specimens purchased from local collectors. It is indicative of the intensive activities of the Museum that the total of Ecuadorean specimens in the Museum's collection is more than 13,500 and that, of the 1357 species and 151 subspecies recorded from Ecuador, all but 33 are represented in the Museum's collection and in most instances by specimens from Ecuador. A large part of the volume is devoted to distributional lists of these specimens.

Dr. Chapman's faunal zones and their altitudinal boundaries as established in Colombia and accepted over a large part of the tropical Andes by botanists as well as zoölogists were found to be essentially the same in Ecuador as in Colombia. Wide local differences were noted in zonal boundaries between the Pacific Coast of Ecuador and that of Colombia, but the apparently local nature of these differences seems only to emphasize the relations between temperature and the zonal boundaries and the need of further intensive studies of these relations. In Ecuador even more than in Colombia the lack of even approximately accurate topographic maps and of meteorological records has handicapped Dr. Chapman's work.

Of Dr. Chapman's discussions the most interesting to both geographers and geologists is probably that of discontinuous ranges and his suggestions as to the exploration of the phenomenon. The explanation does not seem to lie in lack of suitable habitat, since many habitats suitable to certain species completely lack them, and he dismisses the probability that the discontinuous phenomenon is due merely to the bird's potential mobility and to fortuitous circumstance. He maintains that the casual establishment of isolated bird colonies is infrequent and cites among others the case of whole families of birds containing hundreds of species which are common on the mainland from Guiana to Mexico and totally lacking in the West Indies. Climatic change due to glaciation and volcanic activity which at some period may have exterminated the bird life of large areas are offered as probable but at best only partial explanations.

The volume contains a brief history of Ecuadorean ornithology; brief discussions of the physiography, the distribution of forests, and the general climatic conditions; a bibliography; and a list of collection stations—all of which are of interest to geographers.

Ecological Guide to America North of the Equator

V. E. Shelford and Others, edits. **Naturalist's Guide to the Americas.** Prepared by the Committee on the Preservation of Natural Conditions, of The Ecological Society of America, with assistance from numerous organizations and individuals. xv and 761 pp.; maps, ill., indexes. The Williams & Wilkins Co., Baltimore, 1926. $10.00. 9 x 6 inches.

Dr. Shelford undertook an important and difficult project when he planned a descriptive catalogue of the American areas in which natural conditions for plants and animals exist particularly suitable for scientific study and for preservation. Probably over 75 persons have contributed to this encyclopedic volume printed in small type and in double columns and with the general plan recalling Mills's "The International Geography."

As an introduction to the general descriptive part there are nineteen short articles devoted to the uses, values, and management of "natural" areas from various points of view, æsthetic, educational, scientific, economic, and administrative.

The great bulk of the volume is devoted to the description of the various sections in political, administrative, or natural units, beginning in the far north and working south to the equator. Naturally the fullest account is given of the United States and Canada. The islands of the Atlantic, such as the Bermudas, Bahamas, and West Indies are included and, in the Pacific, the Galápagos and the Philippines. South America south of the equator is omitted, no doubt on account of the difficulty of securing authors; and to this extent the title of the work is misleading.

The various accounts contain a vast amount of valuable descriptive information in readily accessible form. It would be necessary to consult hundreds of volumes or papers to find what is here concentrated in one, and there is in addition much that is new. The sixteen line maps will prove valuable to many students who desire a graphic view of the broad biogeographical relations. Naturally these different regional accounts are of very unequal value. Some are prepared by well informed students who are familiar with their regions and have modern ecological ideas; others have such a strong floristic and faunistic bent or bias that the results are not entirely satisfactory in a volume intended to emphasize the ecological aspect.

The volume concludes with a list of persons who coöperated in its preparation and a directory of local, state, and national organizations interested in conservation matters. The directory, however, is very incomplete.

The reader cannot fail to note the numerous small errors and omissions that naturally lead him to expect similar errors in other parts with which he is not so familiar. Now that we have the basis, a revised edition could give us an exceedingly valuable and reliable reference work. On the whole, as has been said, the volume is a very valuable contribution which will be particularly useful in reference libraries and to many geographers and naturalists and will be a tool in constant use among botanical and zoölogical field workers.

Many years ago when the reviewer began to stress the value of studying natural conditions and of preserving "vanishing" natural data there were some who were inclined to look upon this as more or less of a fad. Since that time the study of natural unmodified nature has been increasingly recognized, especially among ecologists. It is probably correct to say that, as a group, they have come to realize the seriousness of this matter better than any other group of field students, including even the geographers and geologists. We may confidently hope that this volume will do much to assist in this important movement, particularly toward educating

public officials. Ecologists and geographers can render an excellent public service by keeping themselves personally informed on these matters and of passing on to the public uncensored dependable information as to actual conditions.

CHARLES C. ADAMS

PALEOGEOGRAPHY OF NORTHWESTERN PERU

E. W. BERRY. **Petrified Fruits and Seeds from Oligocene of Peru.** Ills. *Pan-American Geologist*, Vol. 47, 1927, pp. 121–132.

From a study of fossil fruits and seeds in northwestern Peru Professor Berry concludes that the plants that produced them grew in humid tropical lowlands at a time when the Andes to the east were sufficiently low to permit the moisture-bearing trade winds to blow with little interruption right across the present Andean region to the Pacific. He further concludes that the Humboldt Current did not wash the shores of northwestern Peru at that time and thus did not exercise a baneful effect upon the climate of the land.

The additional evidence which the paper conveys of the low stand of the Central Andean region in middle and early Tertiary times is most welcome. It supports the conclusions based on physiographic and stratigraphic grounds and referred to repeatedly in earlier volumes of the *Geographical Review*. Berry's conclusions may be modified in time when more is known of the swing of the doldrums and the change in the outer limits of the tropical rainfall Lelts, for the region in question lies not in the midst of the west-coast desert of South America but close to its northern border where a southerly shifting of the edge of the rainfall belt by a very small amount would supply the humid conditions required by the plant forms described by him. Not only would this account for the humidity but it would also explain the greater rainfall despite the supposition that the Humboldt Current flowed in its present position Under Berry's hypothesis we should still be obliged to account for rainfall derived from the trade winds when they reached the lowland coast. At whatever level the Andes of this region may have stood in the Oligocene period, they were at least higher than the coastal region, and the trade winds could hardly have precipitated their moisture under the assumed conditions of relief unless the southern edge of the central belt of tropical rains were moved southward over the region in which the fossil fruits and seeds were found. The meteorology of the case is not satisfied simply by having the mountains so low that the trade winds could cross them.

A STUDY IN WEST INDIAN PHYSIOGRAPHY

H. A. MEYERHOFF. **The Physiography of the Virgin Islands, Culebra and Vieques.** Maps, ills. *Scientific Survey of Porto Rico and the Virgin Islands*, Vol. 4, Part I, pp. 71–141, N. Y. Acad. of Sci., 1926.

In this paper there are given the results of field studies in 1923, 1924, and 1925 in continuation of the scientific survey of Porto Rico (and certain islands to the eastward) by the New York Academy of Sciences. The present paper is concerned chiefly with the physiographic aspects of the Virgin Islands. Briefly stated, the physiographic history is recorded in an oldland composed of a complex mass of folded and stratified surface volcanics, thin sediments, and underwater volcanic instrusions together with other detailed structural features. Upon the complex mountainous relief thus formed, erosion cut the surface to an imperfect peneplain now best seen on the fairly accordant summit levels of the upland of St. John Island a thousand feet above sea level. There ensued a first cycle of erosion, interrupted by 700 or 750 feet of uplift, and a second cycle which reduced all but the central cores of the larger islands to a late mature or old stage of dissection. Again the streams were rejuvenated by about 500 feet of uplift. There followed slow submergence and the de-

position of coastal-plain deposits on the lowland areas formed during the preceding cycle of erosion. These deposits were uplifted and all but cut to pieces. In a second submergence the dissected coastal plain was drowned, leaving only a few Tertiary ridges and cuestas above sea level. These physiographic features, already complex, were made more so by the growth of barrier reefs around portions of the margin of the submarine platform, the development of local fringing reefs, and the irregular accumulation of deposits here and there upon the surface of the platform. A final submergence of five or six fathoms has left the shore lines of the islands with drowned topographic features.

The author gives special attention to the physiographic history of the submarine platform about the islands, and this part of his paper represents an important contribution. He takes issue with both Vaughan and Daly as to the validity of their interpretations. Vaughan believes that a graded wave-cut terrace can be formed rapidly to depths of ten fathoms in soft materials and that sea level was lowered some twenty fathoms during the maximum glaciation of the Pleistocene epoch at which level wave-cut platforms were formed that were submerged by the later rise of the water. Daly ascribes similar platforms to marine planation at a low level when ice caps had withdrawn a large quantity of water from the ocean. By a detailed study of the relief of the platforms and the structural geology and physiography of their inner border the author here concludes that the entire submarine platform is to be explained by a complex physiographic history which he has traced and whose stages he has carefully identified and dated rather than by wave action during the episode of glaciation. It is of interest to note that his conclusions are in the main like those of Professor W. M. Davis in "The Lesser Antilles," published by this Society in 1926. This is of special interest because the two authors worked independently and published their results independently, Meyerhoff's study having been completed before Professor Davis' book was known to him. The details of the study are too complicated to present even in outline. The whole study is of the first importance in the physiography of the West Indies.

The Government Study of Rubber Production

J. C. Treadwell, C. R. Hill, and H. H. Bennett. **Possibilities for Para Rubber Production in Northern Tropical America.** xii and 375 pp.; maps, diagrs., ills., bibliogr. *U. S. Dept. of Commerce, Trade Promotion Ser. No. 40,* Washington, 1926. 65 cents. 9 x 6 inches.

Earlier reports of the Crude Rubber Survey of the U. S. Department of Commerce have dealt with the Middle East, the Philippines, the Amazon Valley, and Africa. The present volume on Tropical North America is on the same plan as its predecessors (see *Geogr. Rev.*, Vol. 16, 1926, pp. 162–164 and 491–493). A general discussion is followed by detail studies of the several countries or regions: physical and economic factors are taken up, frequent comparisons being made with the known conditions in the Middle East.

For a belt ten degrees either side of the equator an altitude of 1500 feet is considered as the upper limit of economic cultivation of Para rubber. In Uganda rubber is grown on the equator to 4000 feet, but other factors are exceptionally favorable; and even so the tree is considerably slower in maturing. A marked dry season is unfavorable, hence the Pacific coast of Central America is ruled out. Areas the commission considers physically suitable for plantations are indicated on a series of maps—in some instances soil maps are also given. Starting with southern Tabasco and northern Chiapas is a belt running into northwestern Guatemala; a coast strip in British Honduras and about the gulf of Honduras; small coast patches in Honduras; a belt in the interior and southeast of Nicaragua, which attains a considerable width in the San Juan plain of Costa Rica; thence a coast strip through Panama broadening

about the Canal Zone. Airplane reconnaissance by the army aviators of the Canal Zone in 1924 suggests possible areas in the "almost inaccessible" basins of the upper Chucunaque and upper Bayano. On the Pacific coast the first promising region appears in the Tuyra valley. In Colombia a narrow coast strip is favorable, and also the valleys of the San Juan and Atrato and, at appropriate altitudes, of the Magdalena; in Venezuela the difficultly accessible upper drainage basin of the Orinoco and Negro and some coast patches; a coast belt in the Guianas; and small areas in Haiti and Trinidad.

Altogether, over 6,000,000 acres in tropical North America are estimated to be physically suitable for commercial rubber. A fair proportion of this area has transportation facilities to the seaboard and ports within eight days' sailing time of the United States. Land costs are generally low, but scarcity of labor is a handicap—in fact the most serious problem to be confronted.

Boundaries of the United States

J. T. Faris. **The Romance of the Boundaries.** xvi and 331 pp.; maps, ills., bibliogr., index. Harper & Brothers, New York and London, 1926. $6.00. 9 x 6 inches.

The title of this book suggests that it was written with the intention of popularizing the history of many of our national boundaries and some of our state limits. Doubtless it will accomplish its purpose, for it is written in a sprightly style, is profusely illustrated, and is printed in large, clear type. It is based for the most part on monographs, government documents, and the collections of local historical societies; and the author seems to have been discriminating in his selection of material. To the serious reader, however, the absence of footnotes and the peculiarity of the bibliography at the end of the volume are grave drawbacks. For instance, when he is told that a certain writer says so and so, he would appreciate a citation of the book or article in which the statement may be found. But there is no footnote. And if he turns to the bibliography he receives little enlightenment there, unless he is lucky enough to guess the title of the work in which it appeared; for instead of listing the works under the names of their authors, this bibliography catalogues the titles alphabetically and forces the investigator to hunt through the list since his only clue is the name of the writer. It is not difficult to understand a publisher's injunction against footnotes in a book designed for popular consumption, but there seems to be no satisfactory explanation for so unserviceable a bibliography.

Although the narrative is almost always interesting, the seeker for information is sometimes exasperated by not being given a definite description of the boundary which was finally established after years of border warfare or of protracted litigation. In the case of the northeastern boundary, for instance, the ultimate determination by Webster and Lord Ashburton is dismissed with the statement that "a satisfactory line was decided on. This line gave to the United States nearly a thousand square miles less than the award made by the King of the Netherlands eleven years before." There is a map, to be sure, but it does not face the text; in fact, it is placed in the next chapter. Likewise in the case of the southwestern boundary the Gadsden Purchase is not even mentioned. Probably the general reader will not notice the omission, so engaging are the pages that recount the introduction of camels as a means of transportation across the American desert. But even the halfway student will be disappointed not to learn the historical background of that slice of territory which was added to our national domain a few years after the ratification of the Treaty of Guadalupe-Hidalgo.

In its details this book is less free from error than the average of its kind. The wearisome process of verifying dates and the spelling of names takes time and energy which every writer begrudges, and it seems probable that Dr. Faris delegated this task to a careless assistant. Though none of the many slips may be seriously mis-

leading, the following examples will suggest how the reader inevitably gets the impression of slipshod workmanship. On page 76 "President" Washington in 1783 is spoken of, though Washington did not become president of the United States until 1789. On the same page General Haldimand's name appears as "Haldeman," and is so indexed. On page 89 in a single paragraph "the parallel of fifty-five degrees" is given where the author presumably intended forty-five degrees, the American Geographical Society is spoken of as the "American Geographic Society," and Hudson Bay as "Hudson's Bay." On page 181 (line 3) "King James" appears where "Charles" would be correct. On page 187 every New England reader will suspect that "Roger Walcott" should be "Roger Wolcott," and on page 236 the spelling of Lawrence Washington's first name is changed to "Laurence." On page 235 the date of the battle at Bushy Run is a year out of the way; and so it goes, even to page 286 where "the Ordinance of 1782" would look better as "the Ordinance of 1787." Perhaps some of these irritating inaccuracies should be attributed to careless proof reading; but, even so, many errors would remain which it is fairly safe to assume belong to the author.

Boundaries are interesting, and the present-day passion for old-time maps is daily increasing the number of persons whose curiosity is piqued by parallels and quirks and jogs. Dr. Faris's book is unique and timely, but its enduring value would have been doubled if the author had subjected the text to careful verification; and, like most books, it would probably have been more finished from the literary point of view if it had been allowed to season for a few months before it went to the publisher.

LAWRENCE S. MAYO

AMERICAN IMMIGRATION

G. M. STEPHENSON. **A History of American Immigration 1820–1924.** vi and 316 pp.; bibliogr., index. Ginn & Co., Boston, New York. 1926. $2.40. 8 x 5½ inches.

HARRY JEROME. **Migration and Business Cycles.** 256 pp.; diagrs., index. (Publs. Natl. Bur. of Econ. Research, Inc., No. 9). New York, 1926. 9 x 6½ inches.

Professor Stephenson divides his main text into three parts. In the first he deals with the European background of the immigration movement, in the second with the immigrants in America, and in the third—a section of only twenty-five pages—with Oriental immigration. A fourth section presents a rather extensive classified bibliography.

The first part takes up certain of the leading immigrant peoples and discusses some of the important conditions, particularly of a social or economic character, that predisposed them to sever home ties and seek their destiny in a new land. The author very rightly considers that the events which are significant in this connection are not the political, dynastic, or even military affairs that bulk so largely in the pages of most histories, but the intimate, routine, homely conditions that affect the standard of living, happiness, and general well-being of the common people. For treatment in this manner he has selected the people of the United Kingdom, the Scandinavians, the Germans, the Dutch, the Italians, the Jews, and the Slavs. In the short space allotted, treatment is of necessity somewhat sketchy. The result is a handy condensation of the more obvious factors in emigration, but little that is particularly new.

The second part is devoted primarily to the legal and political aspects of the immigration problem in this country. The treatment of the growth of the immigration law is commonplace. In his discussion of the rôle of the immigrant in politics and of the political reaction of Americans to immigration, the author is at his best, presenting a considerable amount of new and valuable material. The section on Oriental immigration reviews the standard material on the Chinese and Japanese,

ignoring entirely the Hindu question, which at one time loomed rather threateningly on the horizon, and displaying no particular penetration into fundamentals.

Mr. Jerome's book is devoted entirely to a single aspect of the great immigration problem, the relation existing between migration and the periodic fluctuations in business that are so familiar in the countries of western civilization. It is crammed with detailed facts, marshaled in statistical tables and graphs and providing a convenient and dependable magazine of information for any one who wishes to get at the heart of this important matter.

The questions that Mr. Jerome sets himself to answer, simply stated, are: What is the factual relation between fluctuations in immigration and fluctuations in business? How are these fluctuations affected by considerations of sex, race, country of origin, etc.? Are conditions in the United States or in the countries of source more influential in determining the fluctuations in migration? What is the economic significance of the ascertained tendencies?

After a preliminary chapter in which he presents as a background the significant aspects of the migration movement to this country, Mr. Jerome sets up the indices by which he proposes to judge the employment conditions in the United States. These include, for different periods, imports of merchandise, pig iron production, factory employment, and various short-period indices of employment conditions. Of these, pig iron production is regarded as the most significant single index.

Taking first the period before 1890, and particularly that succeeding the Civil War, it appears that the cyclical fluctuations in immigration are a reflex of industrial conditions in the United States, with a lag of from two to four quarters of a year in the early part of the period and a shorter lag in the latter part. The data of the next quarter century, that before the World War, confirm this conclusion. It is quite clear that immigration, particularly of males, responds to employment conditions in the United States usually within a year, while emigration from this country shows a corresponding effect. Consequently, net immigration is peculiarly sensitive to American economic conditions. In the war period and the post-war period various non-economic factors are so influential that the economic relations are obscured, though not wholly concealed.

Turning to a more detailed consideration of various elements in the immigration stream, Mr. Jerome finds that male immigrants are more susceptible to economic influence than female, that true immigrants and emigrants are more responsive than the more transitory types, and that unskilled workers are more sensitive than skilled and professional types. Next, he demonstrates that it is conditions in this country, rather than in the countries of origin, that determine the migrational fluctuations; and he shows very pertinently how this produces unfavorable consequences in the latter if, as is usually the case, industrial depression affects them at the same time as the United States. This section closes with a consideration of seasonal fluctuations.

The final section is the only disappointing portion of the book. So much has been said, pro and con, as to the beneficial effect of migrational fluctuations in relieving periods of unemployment in this country and promoting business expansion at the peak, that a critical and detailed consideration of the evidence in the case would be welcome. Mr. Jerome does, indeed, state his conclusion, which is entirely in harmony with the most reasonable interpretation of the data, that, instead of being a mitigating factor in industrial depressions, immigration tends to make the crises more acute by fostering a feverish and uncontrolled expansion of business in boom times. But he does not give this, which is by far the most practical application of his study, the inclusive consideration that it merits.

On the whole, however, this book represents a most useful type of immigration research and will hold a permanent place in the literature of the subject.

HENRY PRATT FAIRCHILD